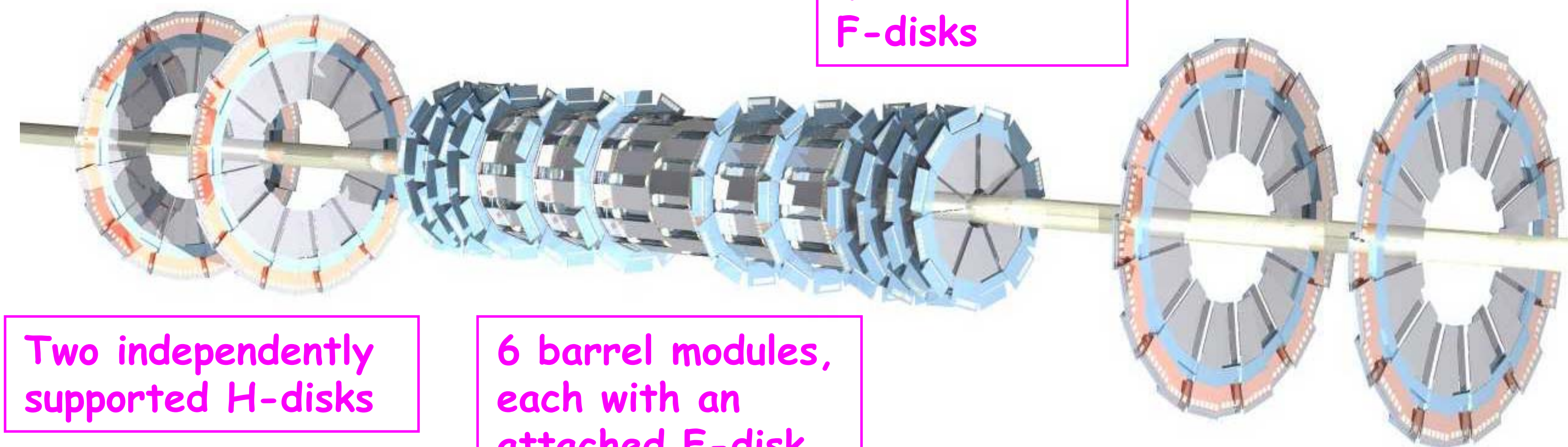
D0 Silicon Disks

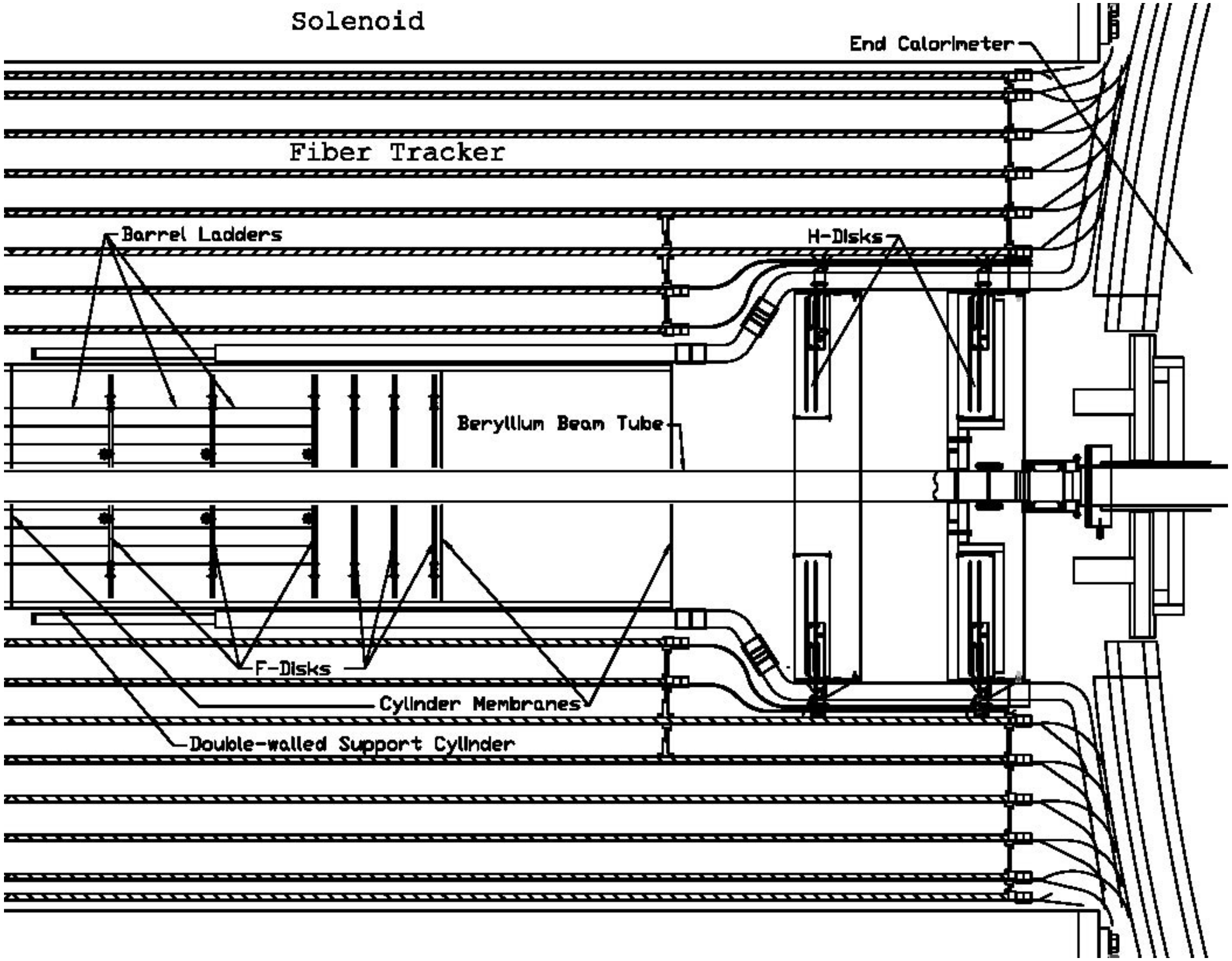
W. E. Cooper

Fermilab

Overall Silicon Geometry

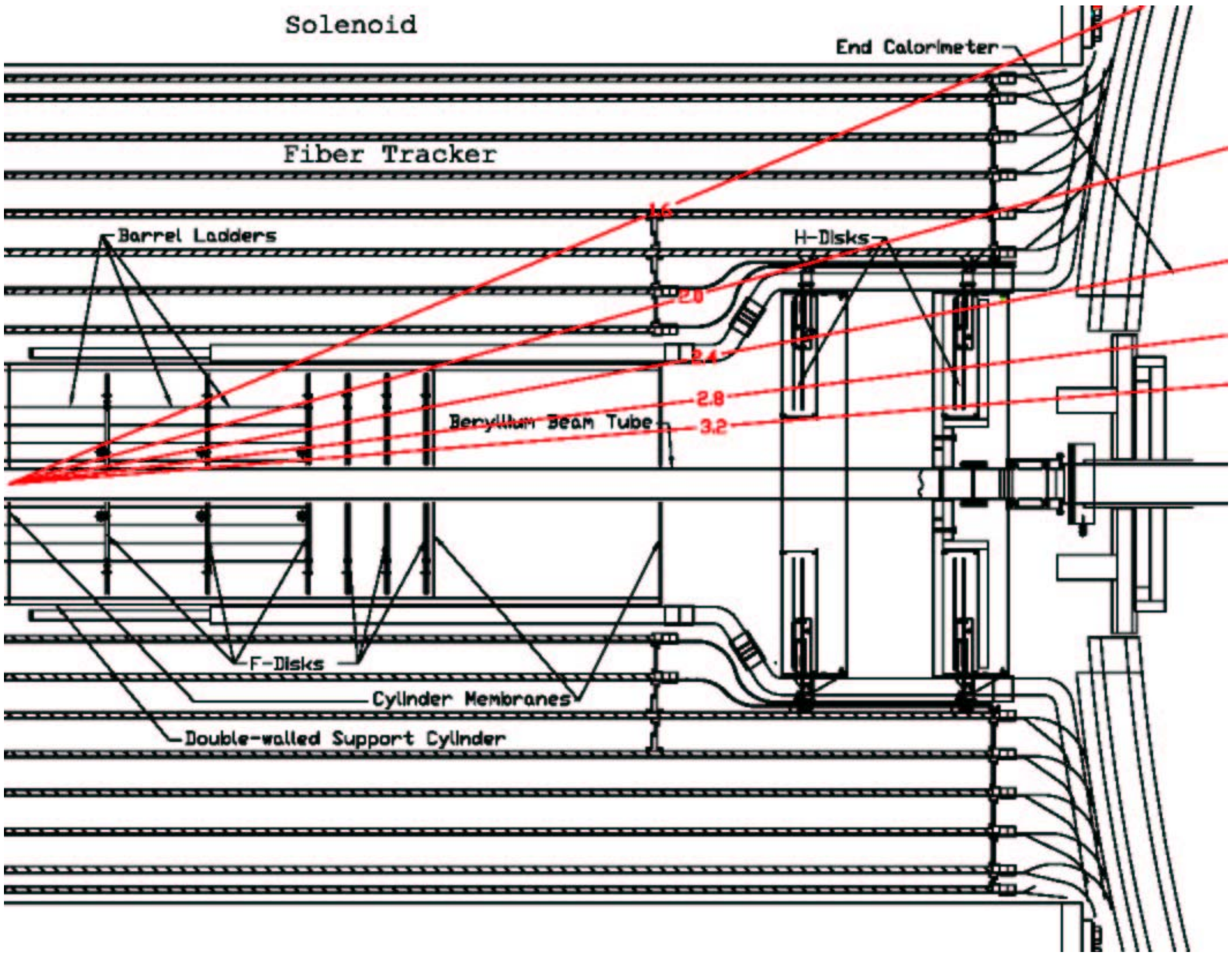


Plan View



- Run IIa:
- Six barrels, twelve F-disks, four H-disks
- 1070 mm long barrel plus F-disk region
- 4.8 m^2 silicon (4.3 m^2 active)

Eta Coverage



- Interaction diamond is extended with sigma ~ 30 cm.
- For tracks originating at x=y=z=0:
- Coverage with all fiber tracker layers to $\eta = \pm 1.6$
- Coverage with all silicon barrel layers to $\eta = \pm 2.0$, where end F-disks begin to supplement coverage
- H-disks supplement coverage from $\eta = \pm 2.15$ to $\eta = \pm 3.2$

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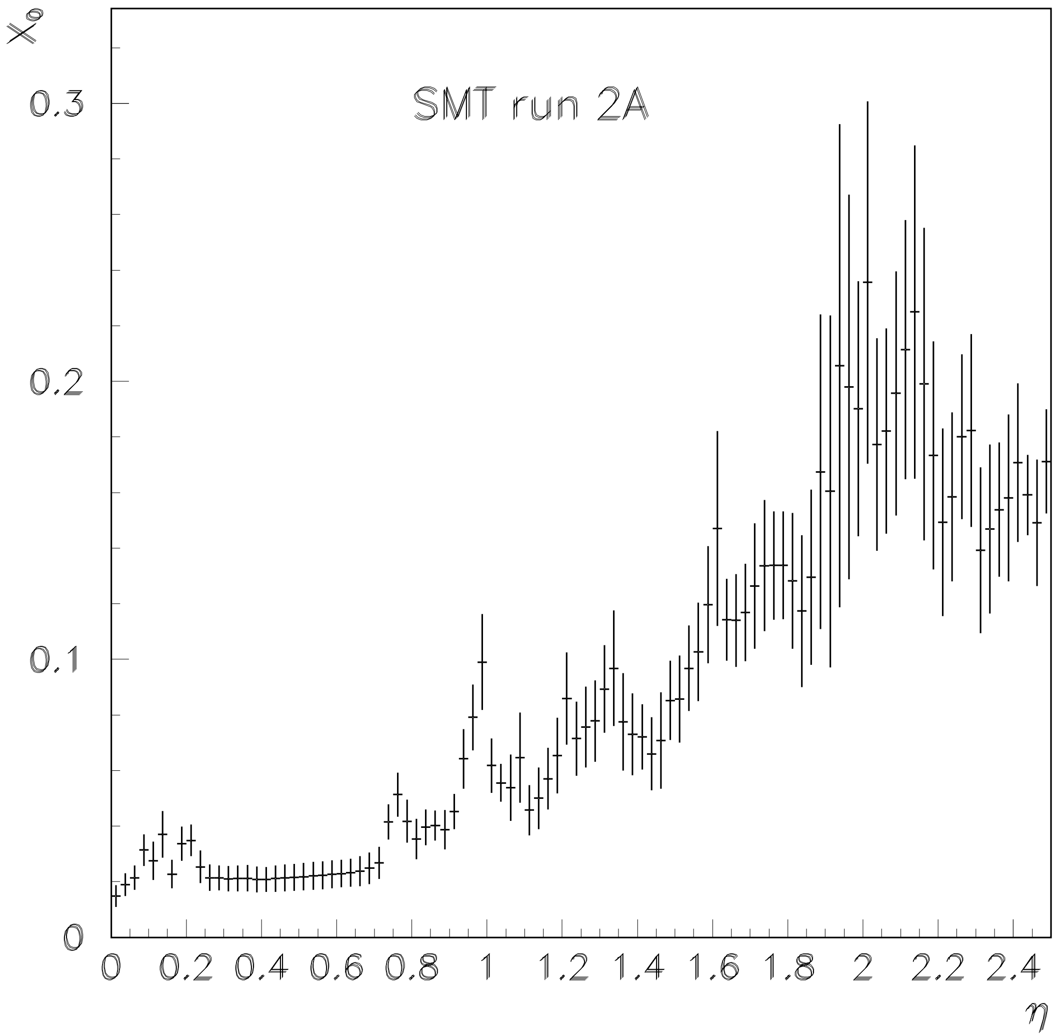
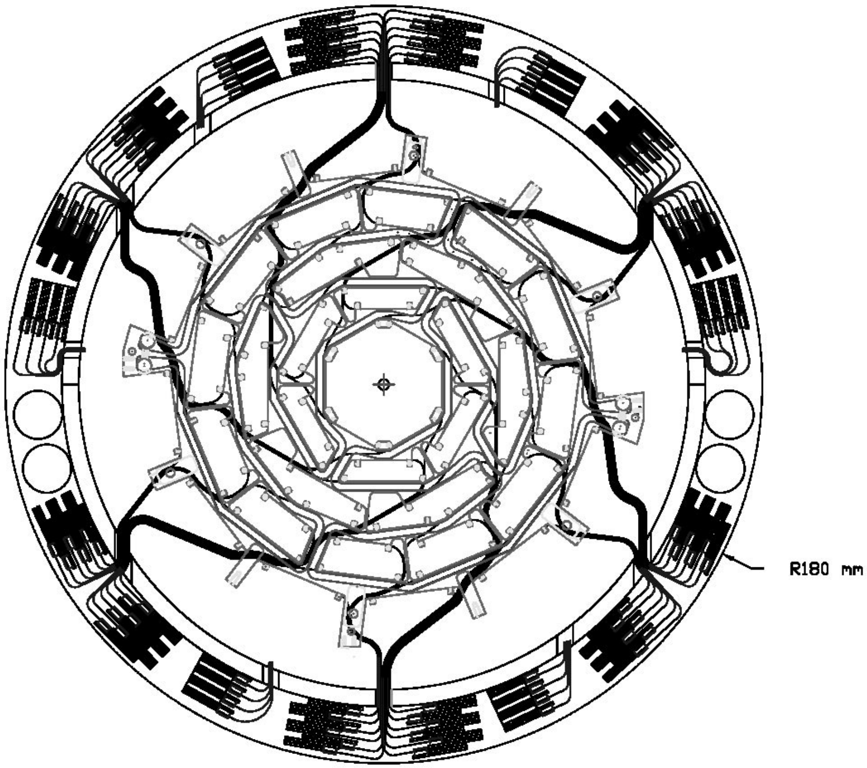
Number of Radiation Lengths versus Eta



Flera Rizatdinova and
Lisa Chabalina

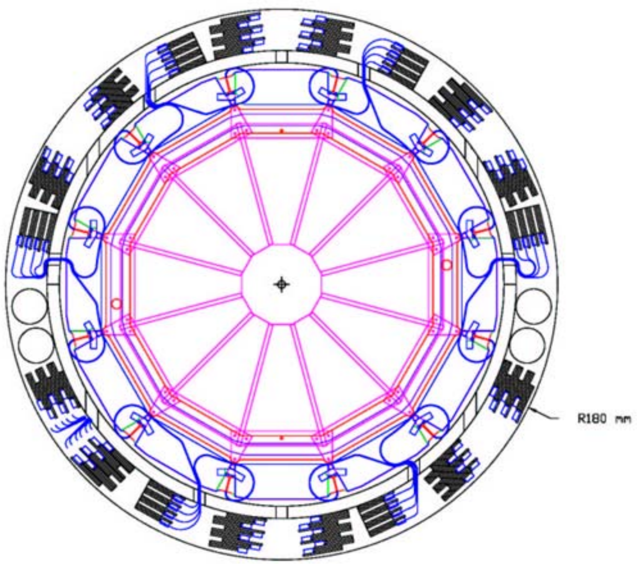
Silicon End View (Barrels)



- Run IIa barrels:
- 2.6 m^2 silicon (2.4 m^2 active)
- 4 layers
- Silicon at R = 27.0 mm to 100.7 mm
- 864 sensors
- Double-sided except for layers 1 and 3 of the outermost barrels

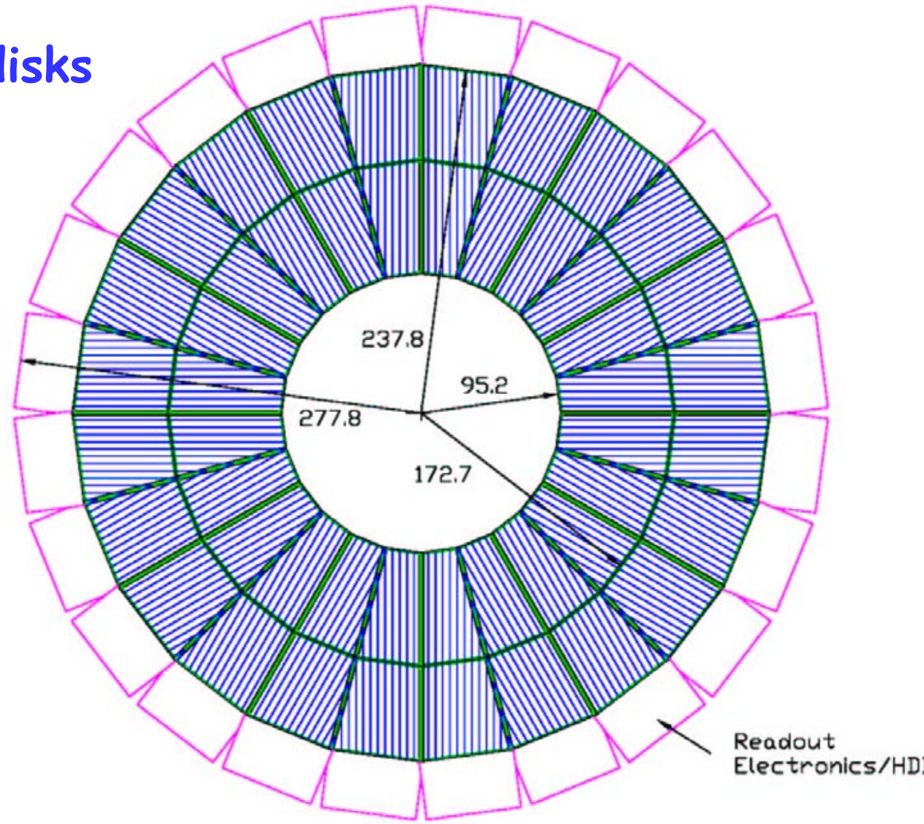
Run IIa Disks

F-disks



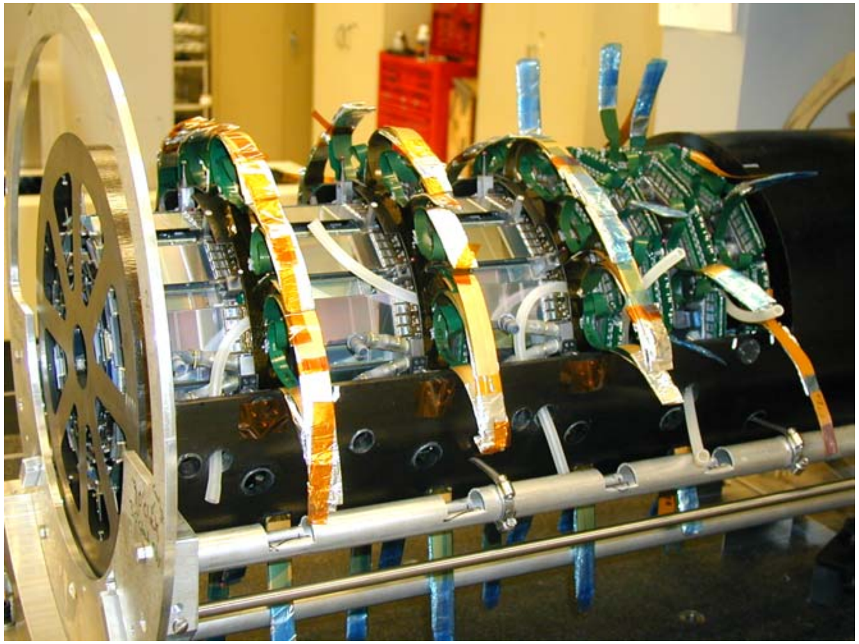
- Silicon at R = 27.0 mm to 106.3 mm
- 0.9 m^2 silicon (0.7 m^2 active)
- 12 disks
- 144 sensors
- Double-sided

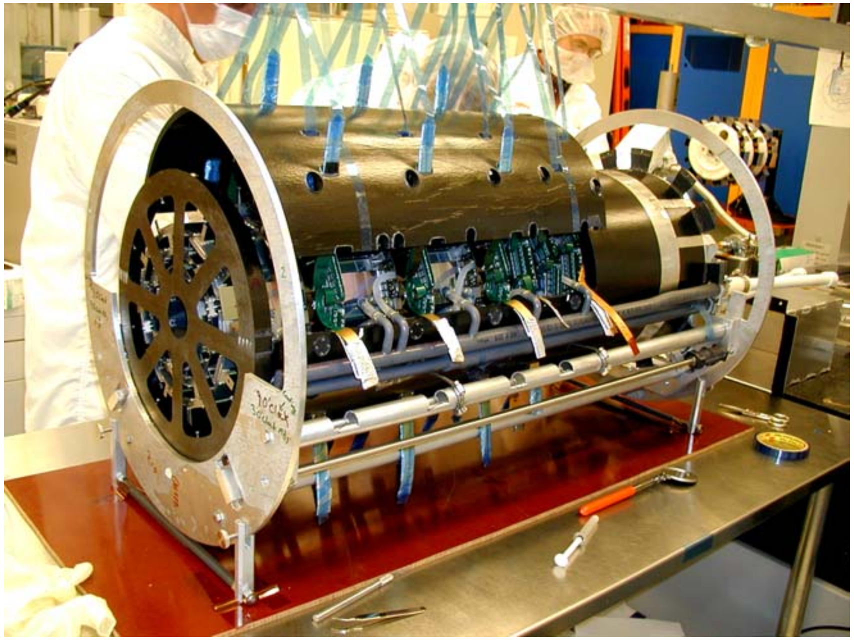
H-disks



- 1.3 m^2 silicon (1.2 m^2 active)
- 4 disks
- 384 sensors
- Single-sided, mated back-to-back to form double-sided

Run IIa Silicon





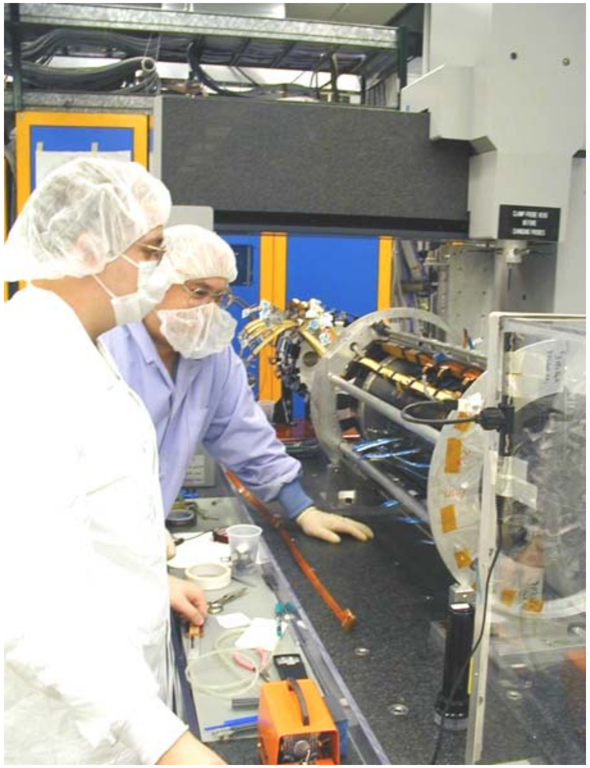
Silicon modules installed in the first of two support cylinders

Nominally identical north and south silicon

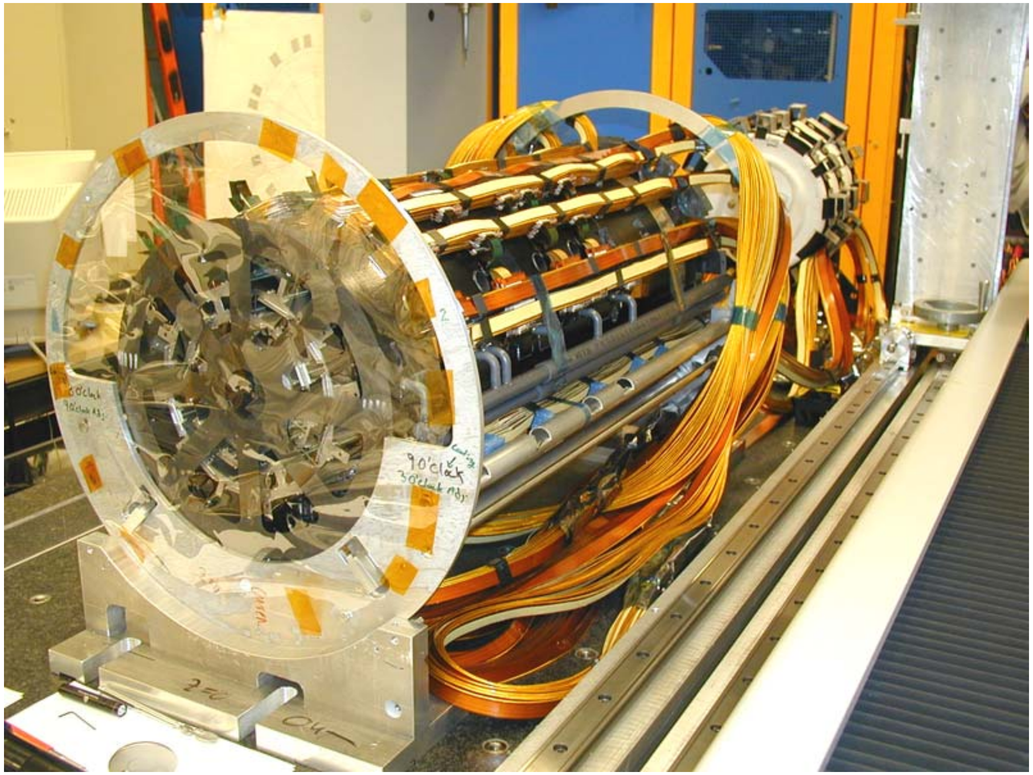
Installation of the support cylinder cover

Many more fabrication and assembly photos and details were shown in Eric Kajfasz's presentation at Vertex 2002.

Run IIa Silicon



After adding the initial few low-mass cables



Silicon cabled and ready for shipment

Run IIa Sensors

- Barrel sensors were provided by Micron and CSEM
  - 144 9-chip, double-sided, 2 degree stereo sensors per barrel, 50 μm pitch on axial surface, 62.5 μm pitch on stereo surface
  - 144 6-chip, double-sided, 90 degree stereo sensors in the central four barrels, 50 μm pitch on axial surface, 153.5 μm pitch on stereo surface
  - 144 3-chip, single-sided sensors in outermost barrels, 50 μm pitch
  - Two 60 mm long sensors, end-to-end, per ladder
- F-disk sensors were provided by Micron and Eurisys.
  - Twelve sensors per F-disk
  - Double-sided, 30 degree stereo, 50 μm pitch on p-side, 62.5 μm pitch on n-side
- H-disk sensors were provided by ELMA.
  - Single-sided, mated back to back to provide 15 degree stereo
  - Two back to back sensor pairs per wedge, one pair at smaller radius and the second at larger radius
  - The two sensors of a given wedge surface are wire bonded and share a common readout
  - 24 wedges per H-disk
  - 4 sensors per wedge, 80 μm pitch with intermediate strips

Run IIa Sensors

D0 Silicon Tracker Parameter Table

	F	H	L1-SS	L1-DS	L2	L3-SS	L3-DS	L4	TOTAL
# detector sides	2	1	1	2	2	1	2	2	
# assys	12	8	2	4	6	2	4	6	44
R min	2.57	9.5	2.7	2.7	4.49	6.6	6.6	9.43	
R max	10.49	26	3.65	3.65	5.51	7.53	7.53	9.43	
|z| (minimum)	6.4	110	-12.8	-25.6	-38.4	-12.8	-25.6	-38.4	
|z| (intermediate) (or dz)			12.8	12.8	12.8	12.8	12.8	12.8	
|z| (maximum)	54.8	120	12.8	25.6	38.4	12.8	25.6	38.4	
# ladders(wedges) / assembly	12	24	12	12	12	24	24	24	
physical length/detector	7.5	14.262	6	6	6	6	6	6	
physical width (min)	1.67	2.761	2.115	2.115	3.395	2.115	2.115	3.395	
physicsl width (max)	5.692	6.478	2.12	2.12	3.4	2.12	2.12	3.4	
physical area (cm^2)	27.6	65.88	12.72	12.72	20.4	12.72	12.72	20.4	
p side strip pitch at IC (μ)	51.76	80.69	50	50	50	50	50	50	
n side strip pitch at IC (μ)	64.7			156	62.5		156	62.	
# IC's / p side	8	6	3	3	5	3	3	5	
# IC's / n side	6			3	4		3	4	
# detectors / readout unit	1	2	2	2	2	2	2	2	
# detectors/assy	12	48	24	24	24	48	48	48	
# detectors (total)	144	384	48	96	144	96	192	288	1392
Sides * area / assy	662.8	1581.	305.	610.56	979.2	610.56	1221.	1958.	
area / assy	331.43	1581.	305.	305.28	489.6	610.56	610.	979.	
Silicon mass (g)	278.00	884.	42.6	85.	205.3	85.3	170.7	410.	2162.
Sides * area (cm^2)	7954.	12649.	610.	2442.	5875.	1221.	4884.	11750.	47387.
# sets IC's/assy	24	24	12	12	12	24	24	24	
# sets IC's	288	192	24	48	72	48	96	144	
# IC's / assembly	168	144	36	72	108	72	144	216	
# IC's	2016	1152	72	288	648	144	576	1296	6192
# Kchannels	258.	147.456	9.2	36.864	82.944	18.432	73.728	165.	792.576

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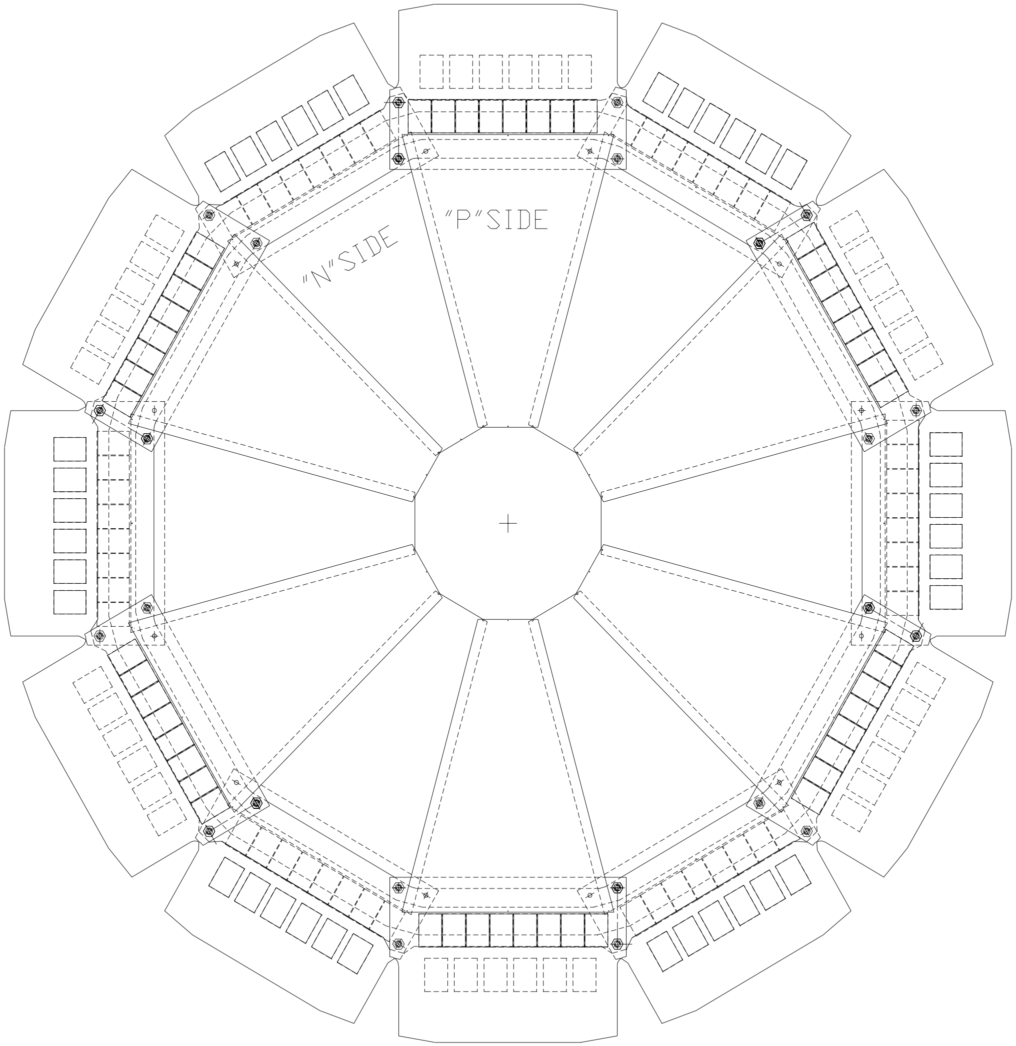
F-disk Design



- Silicon IR = 26 mm, OR = 105.27 mm at wedge centerline
- Readout mounts outboard of silicon, which minimizes material encountered by tracks and allows disk to fit within a gap of 8 mm
- Wedges alternate between two surfaces of a 2.5 mm thick central cooling/support channel (beryllium)
- Effective stereo angle = 30 degrees
- p-side
  Trace angle = -15^{o} with respect to wedge centerline
  Pitch = 50 μm
- n-side
  Trace angle = $+15^{o}$ with respect to wedge centerline
  Pitch = 62.5 μm

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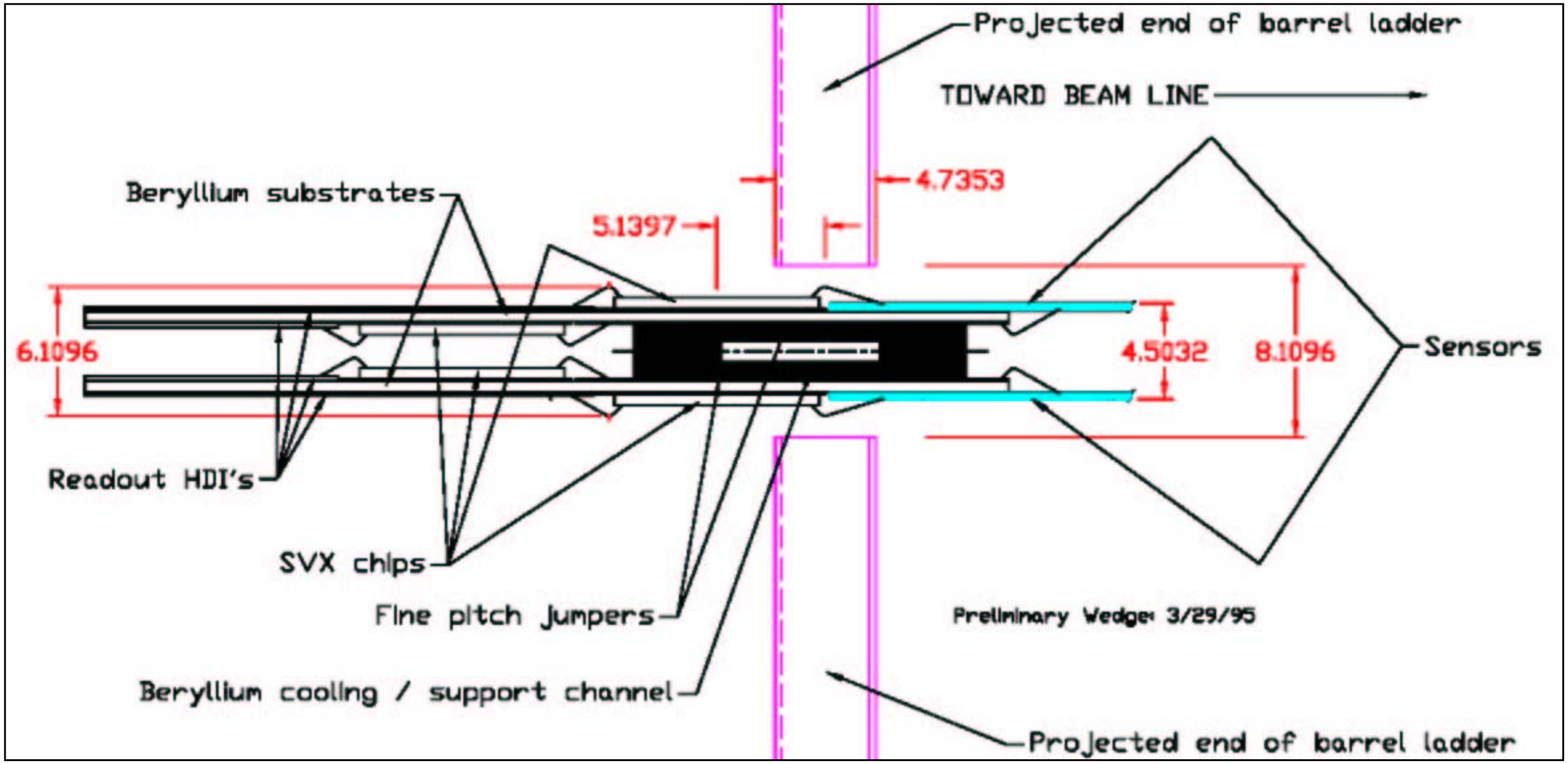
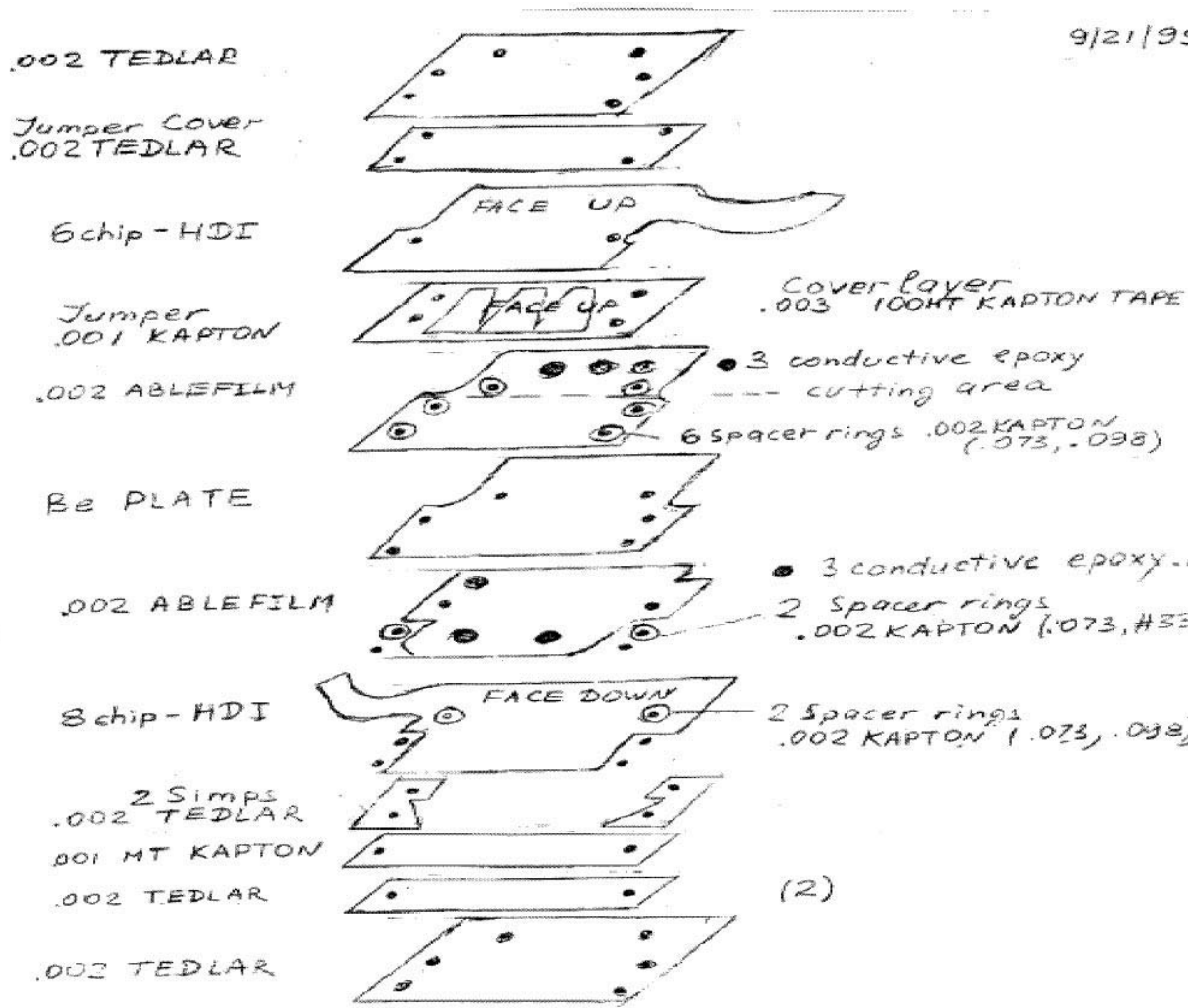
F-disk Design

- Preliminary design drawing
  - OR of sensors was increased later to allow wedge to fit closer to ladder.
  - For design purposes, F-wedges on two cooling channel surfaces are drawn at a common azimuth; actual wedges are separated 60º in azimuth.

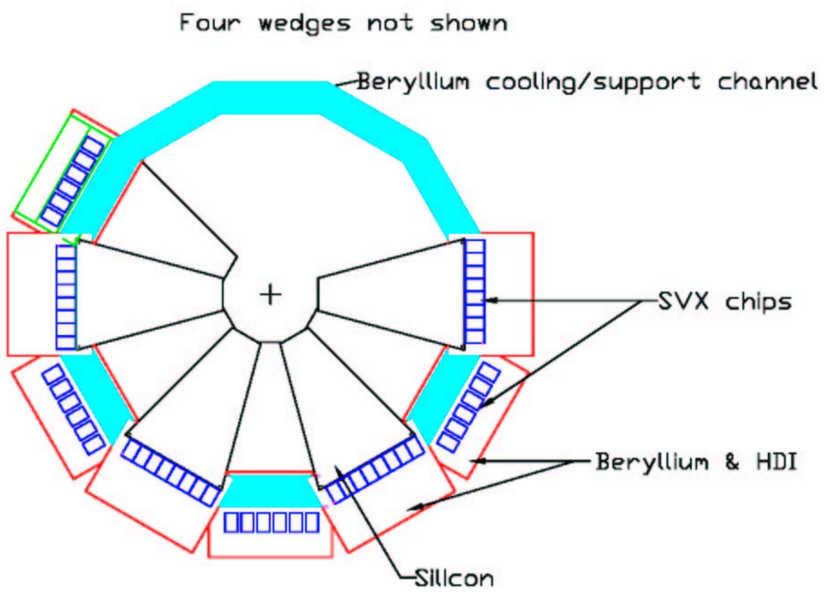


F-wedge Lamination

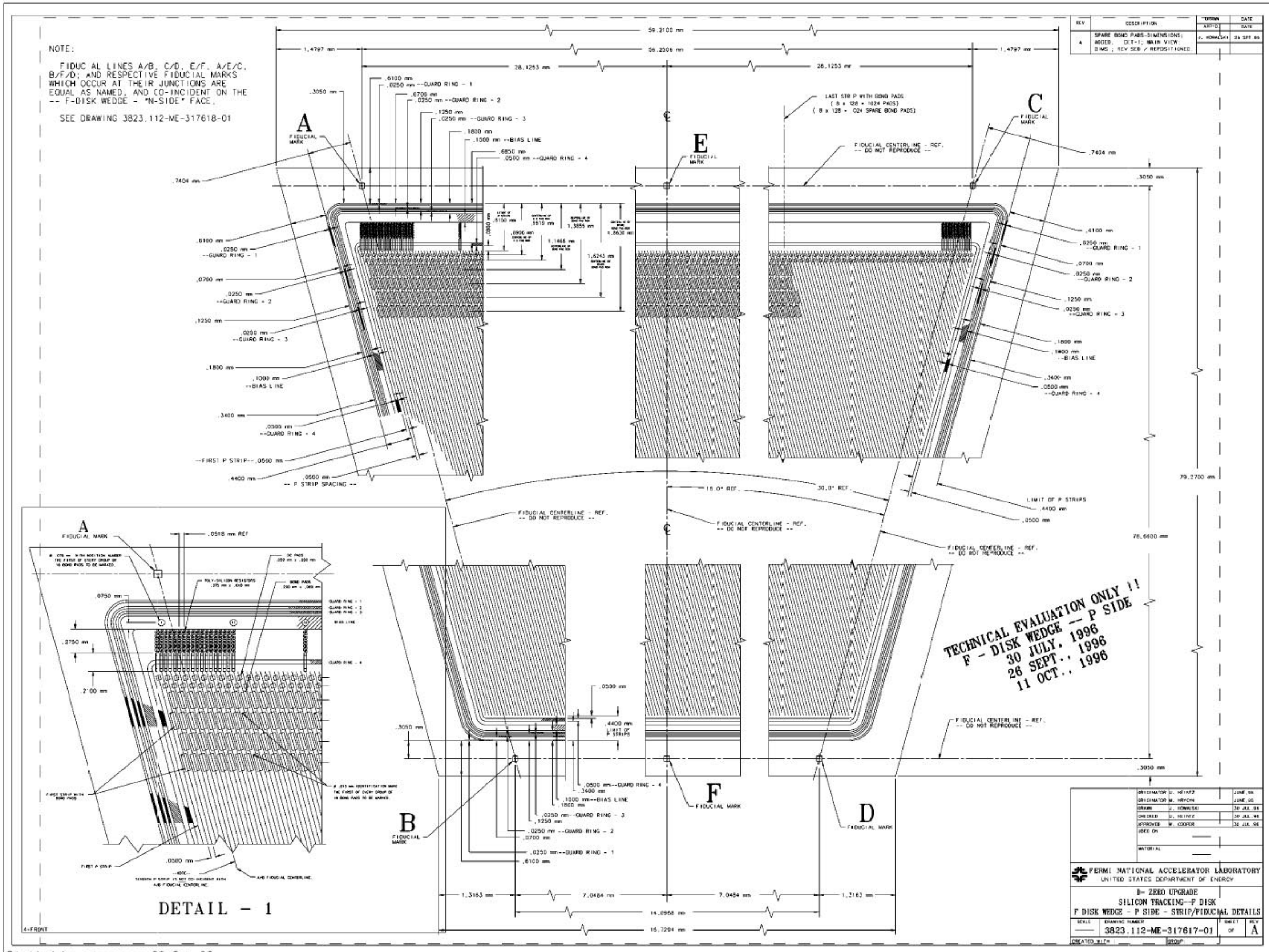


F-disk Material

Material	Silicon equivalent grams
Silicon sensor	1.926
HDI's	4.777
SVX chips	1.156
Beryllium substrates	0.754
Kapton	0.009
Epoxy	0.637
Beryllium cooling channel	1.102
Coolant	0.267
Total	10.628
Total / Silicon sensor	5.517



- Fraction of a radiation length = (Silicon equivalent mass) / 21.82 g/cm2) / (Area of object)
- Averaged over its full extent, an F-wedge, including readout, cooling, and silicon regions, represents just under 1% of a radiation length.
- An 0.300 mm thick wedge sensor represents 0.32% of a radiation length.



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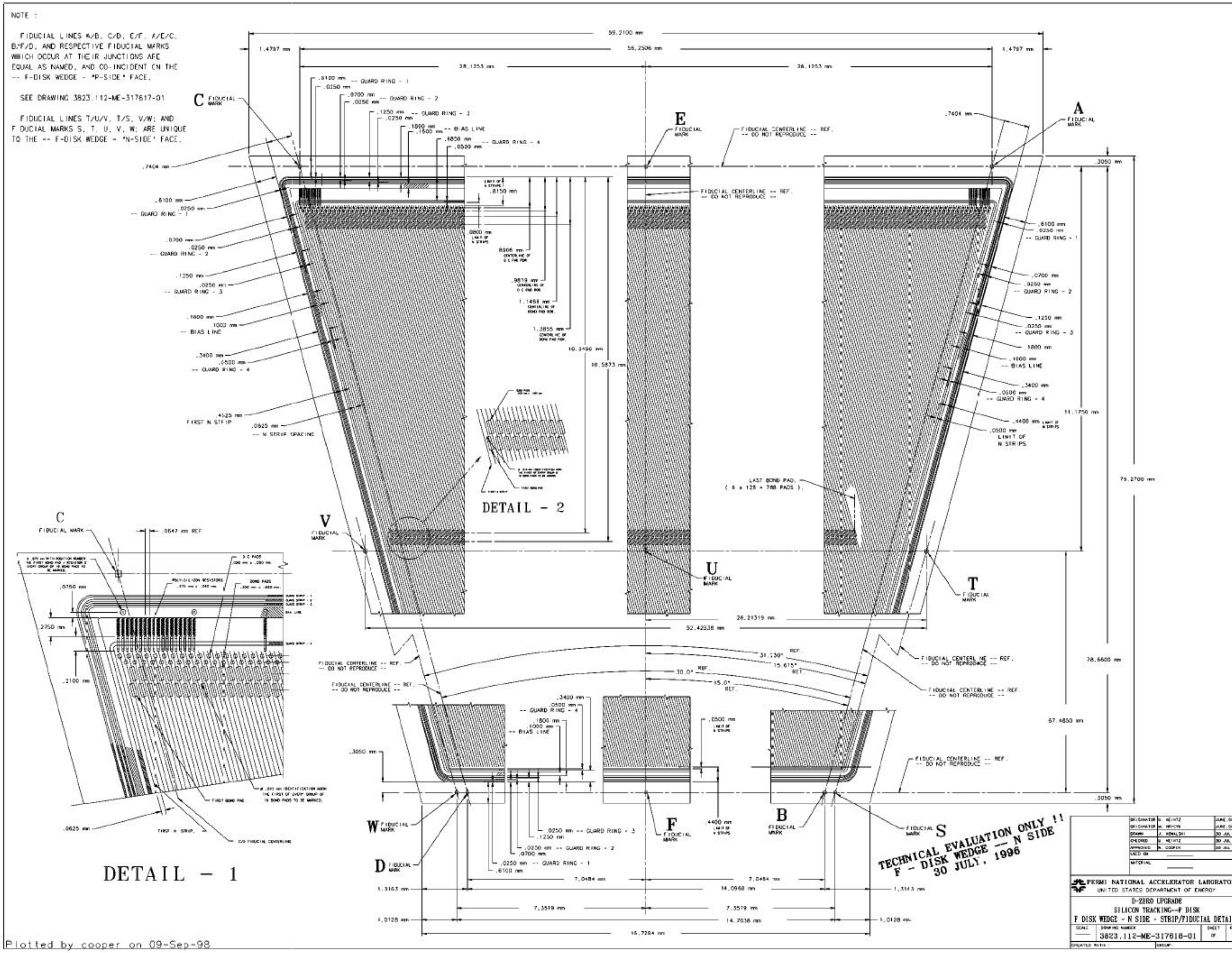
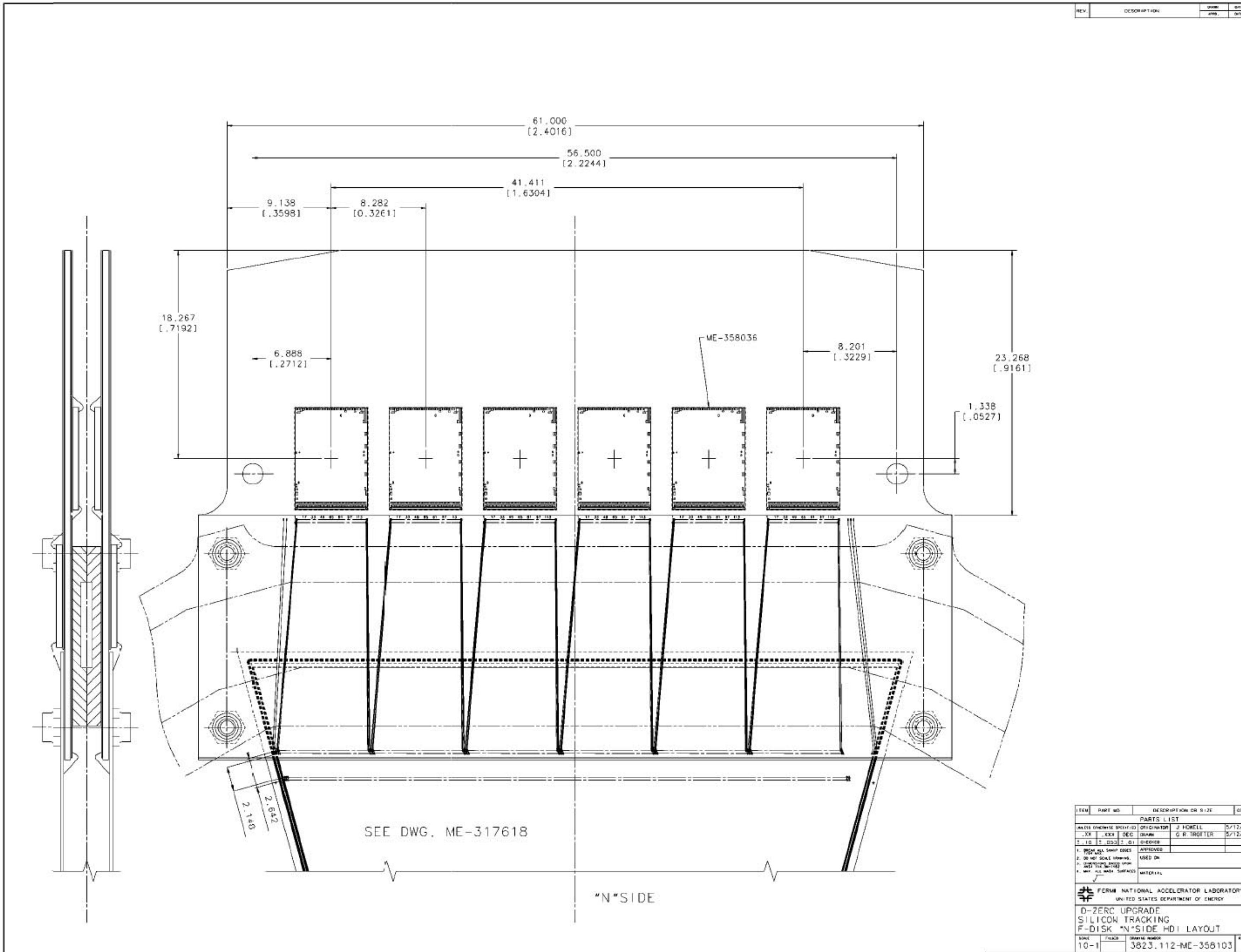

NOTE :
FIDUCIAL LINES A/B, C/D, E/F, A/E/C, B/F/D, AND RESPECTIVE FIDUCIAL MARKS WHICH OCCUR AT THEIR JUNCTIONS ARE EQUAL AS NAMED, AND CO-INCIDENT ON THE -- F-DISK WEDGE - "P-SIDE" FACE.
SEE DRAWING 3823.112-ME-317617-01
FIDUCIAL LINES T/U/V, T/S, V/W; AND FIDUCIAL MARKS S, T, U, V, W; ARE UNIQUE TO THE -- F-DISK WEDGE - "N-SIDE" FACE.
DETAIL - 1
DETAIL - 2
TECHNICAL EVALUATION ONLY !!
F - DISK WEDGE -- N SIDE
30 JULY, 1996
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE
SILICON TRACKING--F DISK
F DISK WEDGE - N SIDE - STRIP/FIDUCIAL DETAILS
3823.112-ME-317618-01
Plotted by cooper on 09-Sep-98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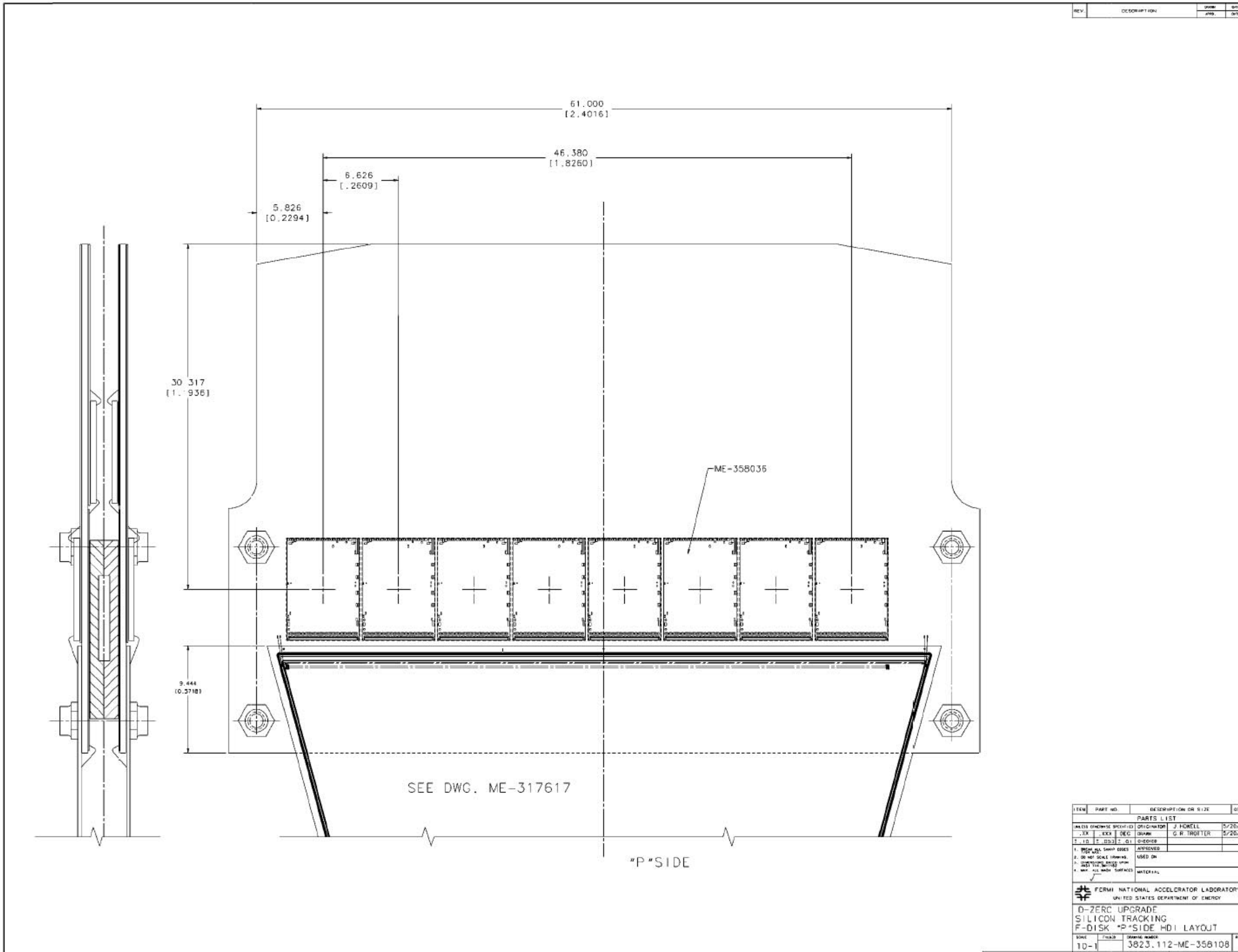
SEE DWG. ME-317618
"N"SIDE
PARTS LIST
J HOWELL
G R TROTTER
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE
SILICON TRACKING
F-DISK "N"SIDE HDI LAYOUT
10-1
3823.112-ME-358103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ME-358036
SEE DWG. ME-317617
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PART NO.
DESCRIPTION OR SIZE
QTY.
PARTS LIST
UNLESS OTHERWISE SPECIFIED
ORIGINATOR
J. HOWELL
5/20/97
DRAWN
G.R. TROTTER
5/20/97
CHECKED
APPROVED
USED ON
MATERIAL
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE
SILICON TRACKING
F-DISK "P"SIDE HDI LAYOUT
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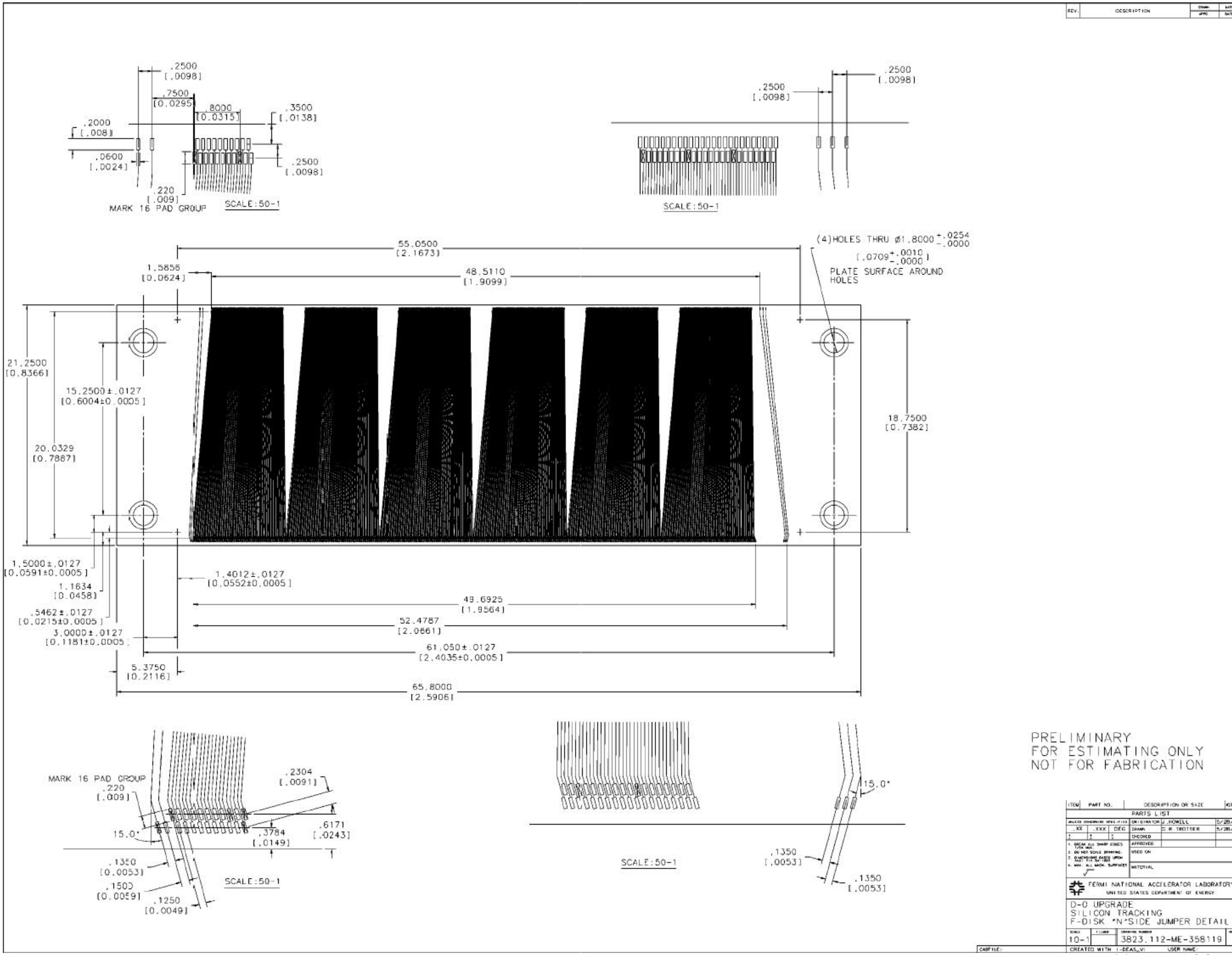
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SCALE:50-1
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[.0709 +.0010 -.0000]
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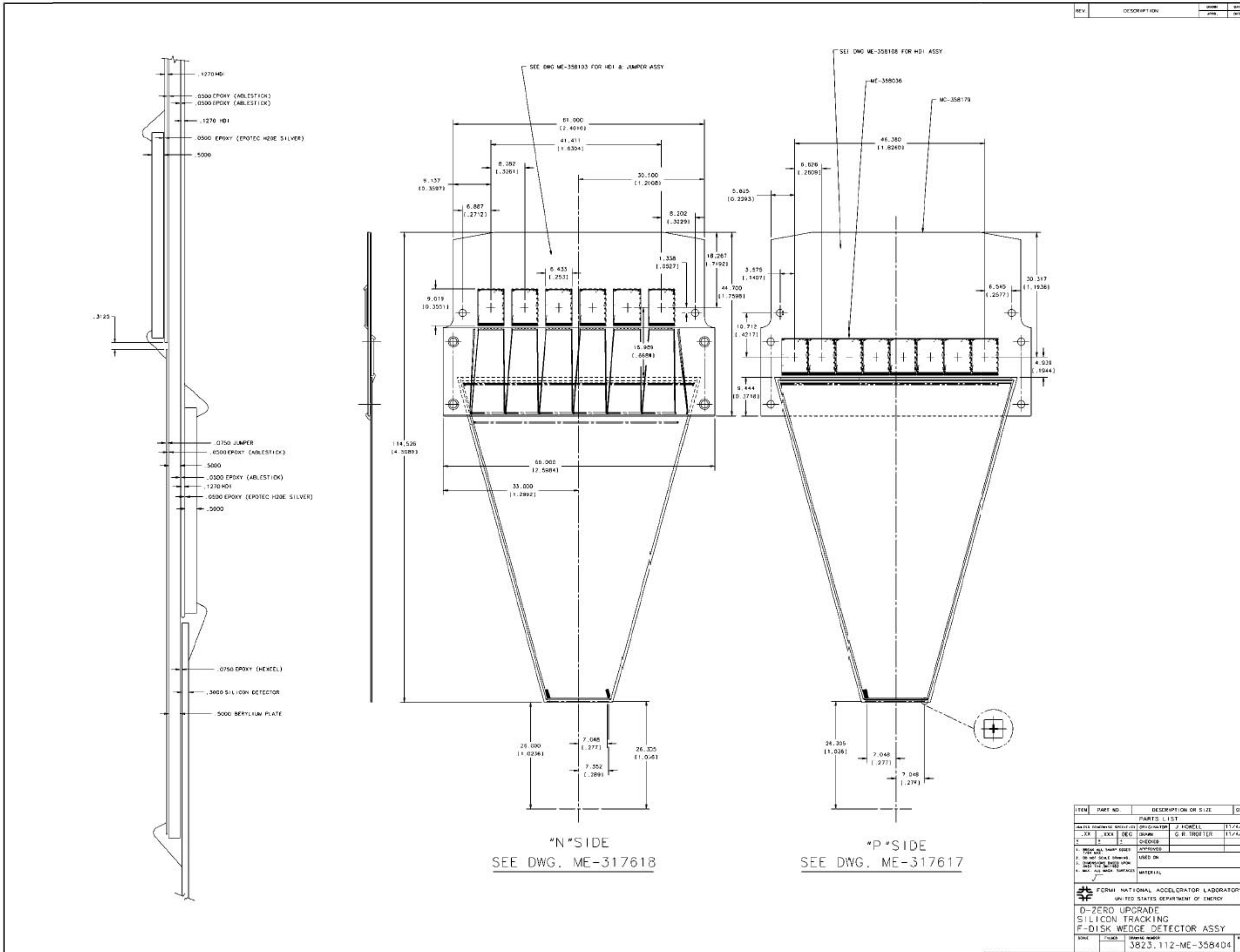
48.5110 [1.9099]
21.2500 [0.8366]
15.2500±.0127 [0.6004±0.0005]
20.0329 [0.7887]
18.7500 [0.7382]
1.4012±.0127 [0.0552±0.0005]
49.6925 [1.9564]
52.4787 [2.0661]
61.050±.0127 [2.4035±0.0005]
65.8000 [2.5906]
PRELIMINARY
FOR ESTIMATING ONLY
NOT FOR FABRICATION
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-0 UPGRADE
SILICON TRACKING
F-DISK "N"SIDE JUMPER DETAIL
3823.112-ME-358119


.1270 HDI
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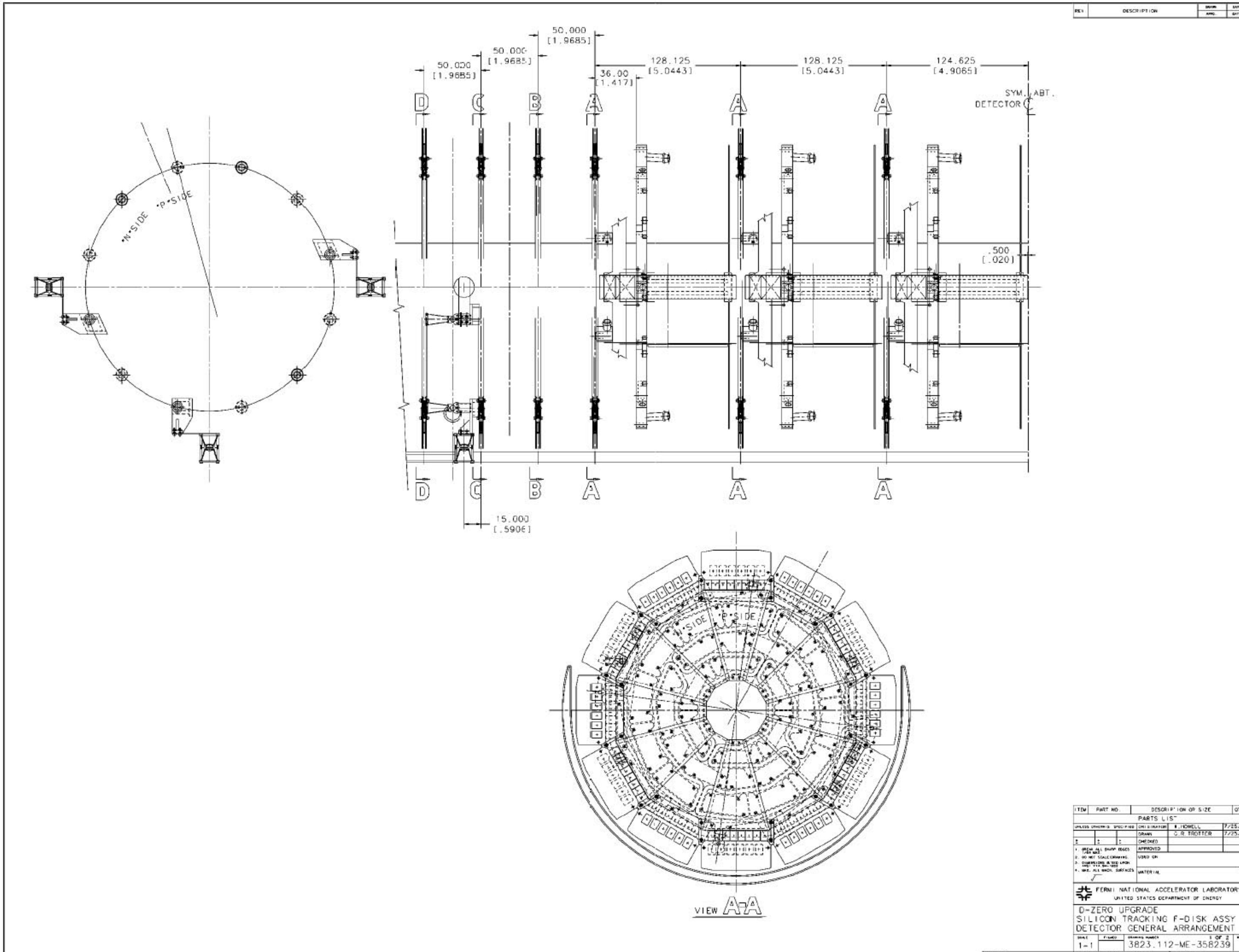
.0500 EPOXY (EPOTEC H20E SILVER)
.0750 JUMPER
.0750 EPOXY (HEXCEL)
.3000 SILICON DETECTOR
.5000 BERYLLIUM PLATE
"N" SIDE
SEE DWG. ME-317618
"P" SIDE
SEE DWG. ME-317617
PARTS LIST
J. HOWELL
G. R. TROTTER
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE
SILICON TRACKING
F-DISK WEDGE DETECTOR ASSY
3823.112-ME-358404
CREATED WITH I-DEAS_VI

F-disk Orientations, etc.

- F-disks attached to barrels all have the same azimuthal orientation.
- End F-disks are rotated with respect to those attached to barrels to help separate ghosts from tracks (see next transparency).
- A variety of spacings was considered for the end disks. The final spacing is 50 mm.
- See also, D0 note 3455.
- Many physicists were associated with F-disks. The primary Fermilab engineer was Joe Howell.
- Both F-disk and H-disk beryllium cooling / support channels came from Phenix Precision (Boston, Massachusetts area).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SYM. ABT.
DETECTOR
D
C
B
A
A
A
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[.020]
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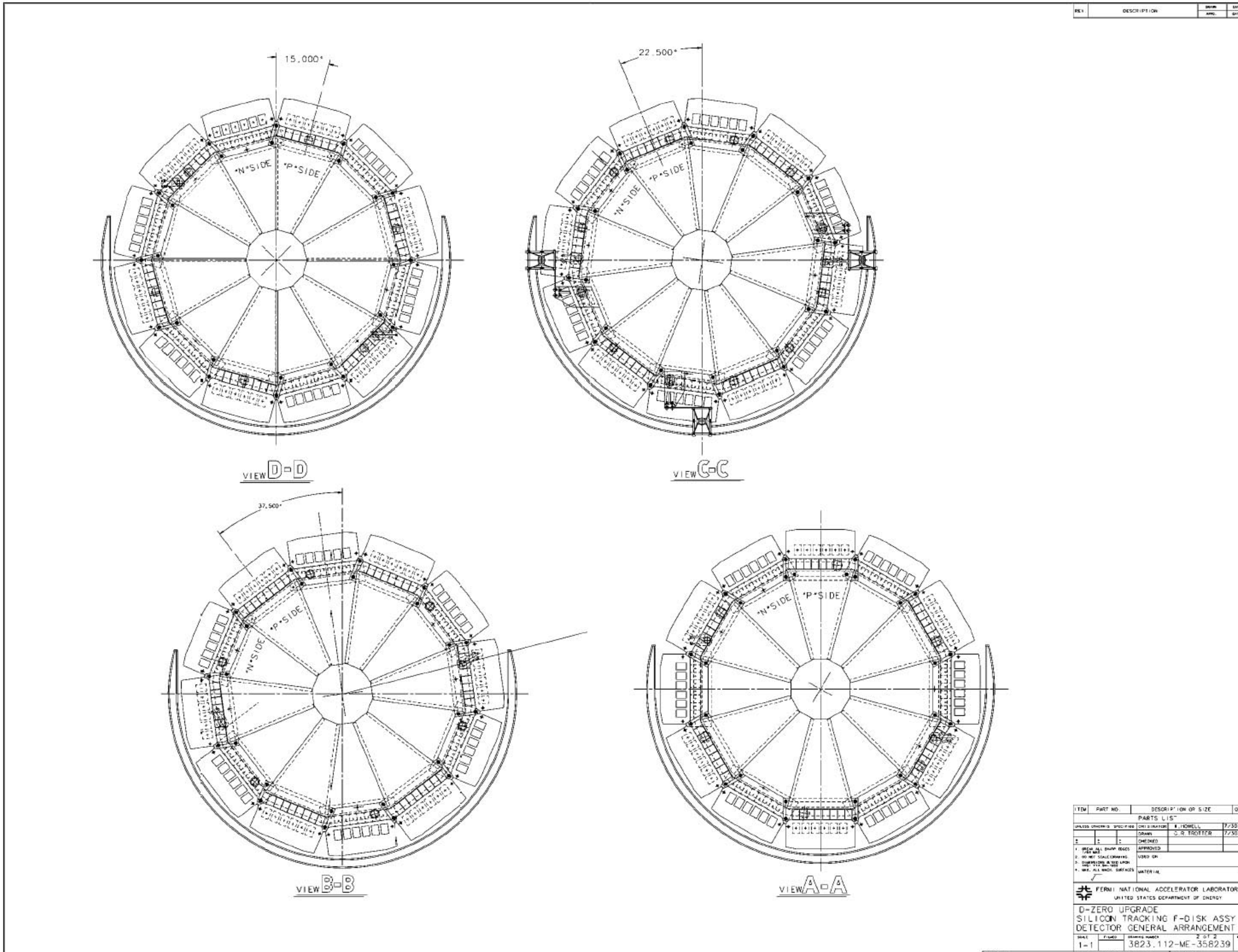
P-SIDE
15.000
[.5906]
VIEW A-A
PARTS LIST
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE
SILICON TRACKING F-DISK ASSY
DETECTOR GENERAL ARRANGEMENT
1-1
3823.112-ME-358239



REV
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"P"SIDE
VIEW D-D
22.500°
"N"SIDE
"P"SIDE
VIEW C-C
37.500°
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"P"SIDE
VIEW B-B
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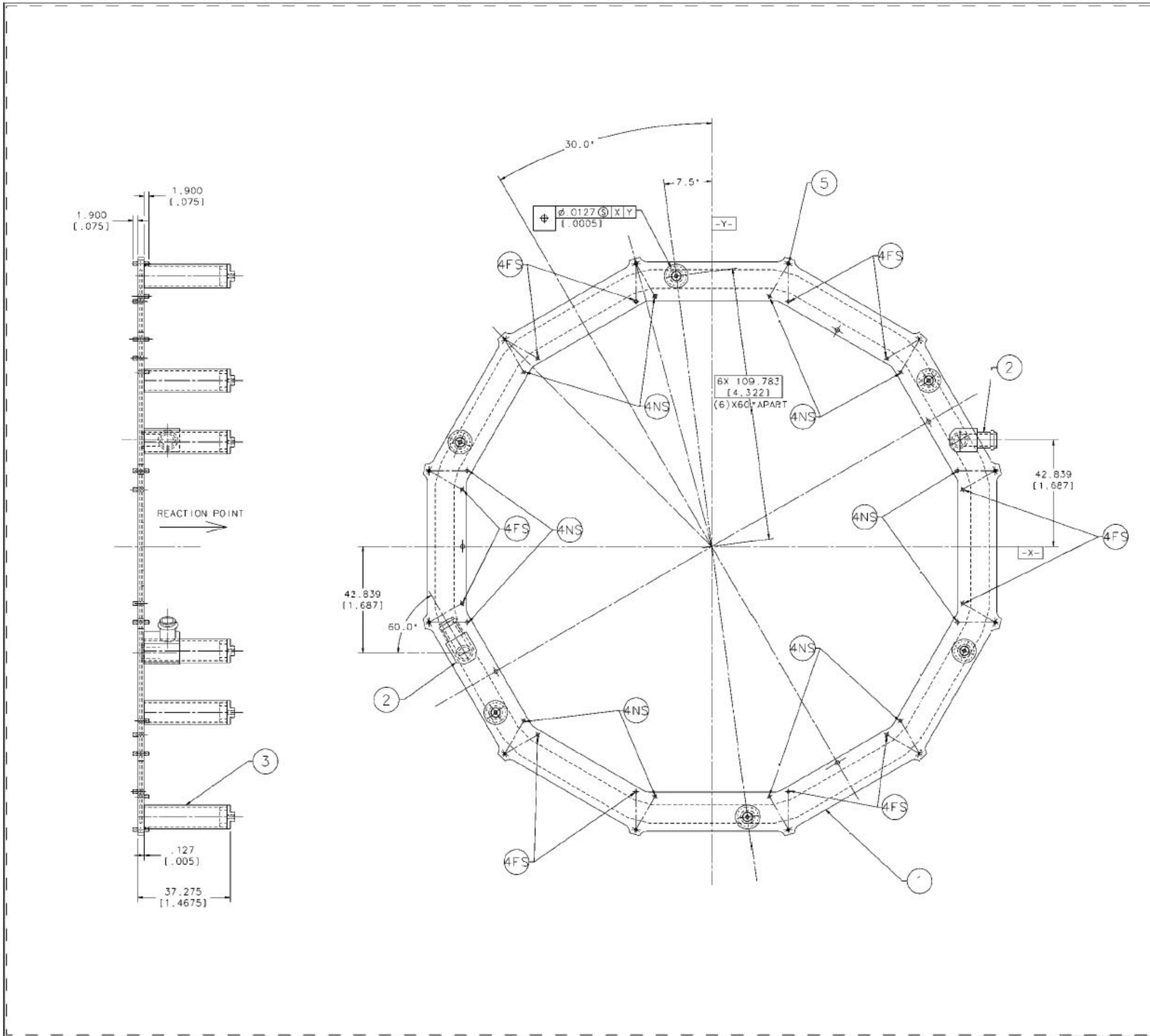
"P"SIDE
VIEW A-A
ITEM
PART NO.
DESCRIPTION OR SIZE
QTY.
PARTS LIST
ORIGINATOR
C.R. TROTTER
7/30/97
DRAWN
CHECKED
APPROVED
USED ON
MATERIAL
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE
SILICON TRACKING F-DISK ASSY
DETECTOR GENERAL ARRANGEMENT
1-1
2 of 2
3823.112-ME-358239
CREATED WITH I-DEAS
USER NAME



ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
5	MC-358443	LONG MOUNTING STUD	12
4	MC-358442	SHORT MOUNTING STUD	24
3	MC-358466	SUPPORT POST	6
2	MC-358086	90 DEG FITTING	2
1	ME-358034	F-DISK COOLING RING ASSY	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED					
.XX	.XXX	DEG	ORIGINATOR	J.HOWELL	11/24/97
±.10	±.025	±.01	DRAWN	G.R.TROTTER	11/24/97
			CHECKED		
			APPROVED		

1. BREAK ALL SHARP EDGES
2. DO NOT SCALE DRAWING.
3. DIMENSIONS BASED UPON
4. MAC. ALL MACH. SURFACES

USED ON

MATERIAL

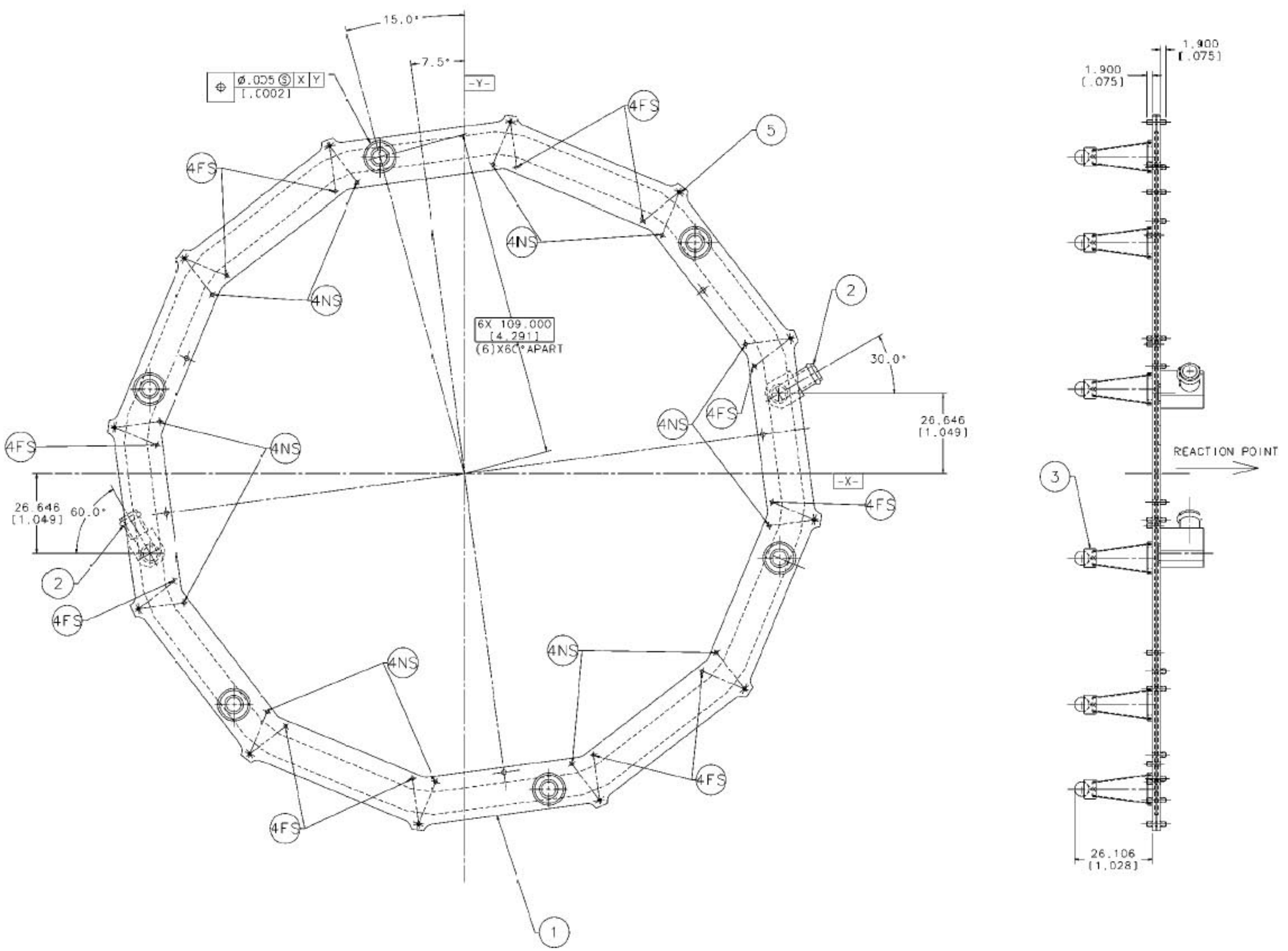
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

D-O UPGRADE SILICON TRACKING
"F"DISK A-COOLING RING
SUBASSEMBLY

SCALE 2-1 | DRAWING NUMBER 3823.112-ME-358444

CREATED WITH I-DEAS_VI | USER NAME:

REV. | DESCRIPTION | DRAWN | DATE



PRELIMINARY DRAWING

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
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3	MC-558	SUPPORT POST	6
2	MC-558086	90 DEG FITTING	2
1	ME-558034	F-DISK COOLING RING ASSY	1

PARTS LIST

UNLESS OTHERWISE SPECIFIED					
.XX	.XXX	DEG	ORIGINATOR	J.HOWELL	5/?/98
±.20	±.050	±.01	DRAWN	G.R.TROTTER	5/?/98
			CHECKED		
			APPROVED		

USED ON

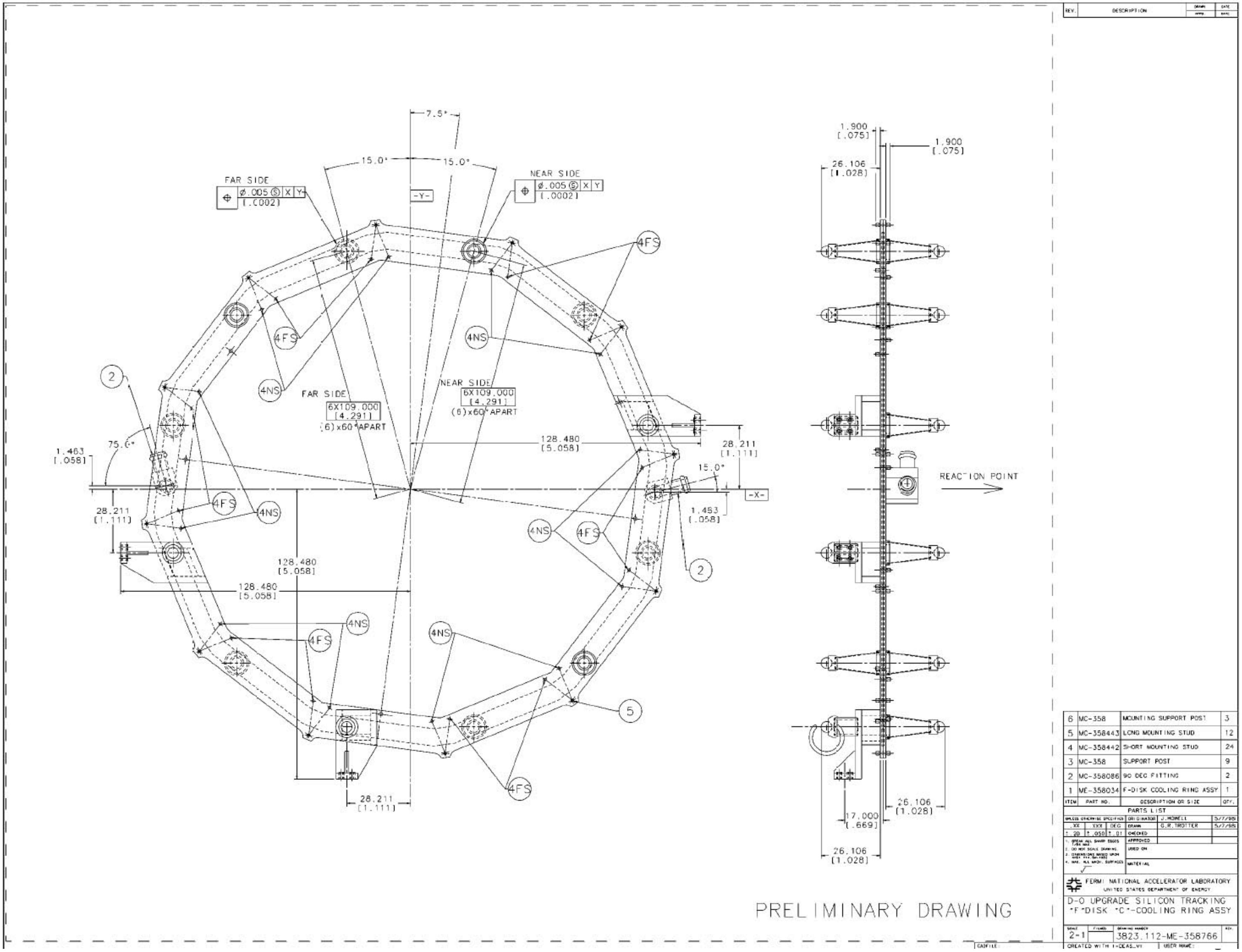
MATERIAL

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

D-0 UPGRADE SILICON TRACKING
"F"DISK "B"-COOLING RING ASSY

SCALE 2-1 | DRAWING NUMBER 3823.112-ME-358765 | REV.

CREATED WITH I-DEAS_VI | USER NAME:


FAR SIDE
NEAR SIDE
PRELIMINARY DRAWING
REACTION POINT
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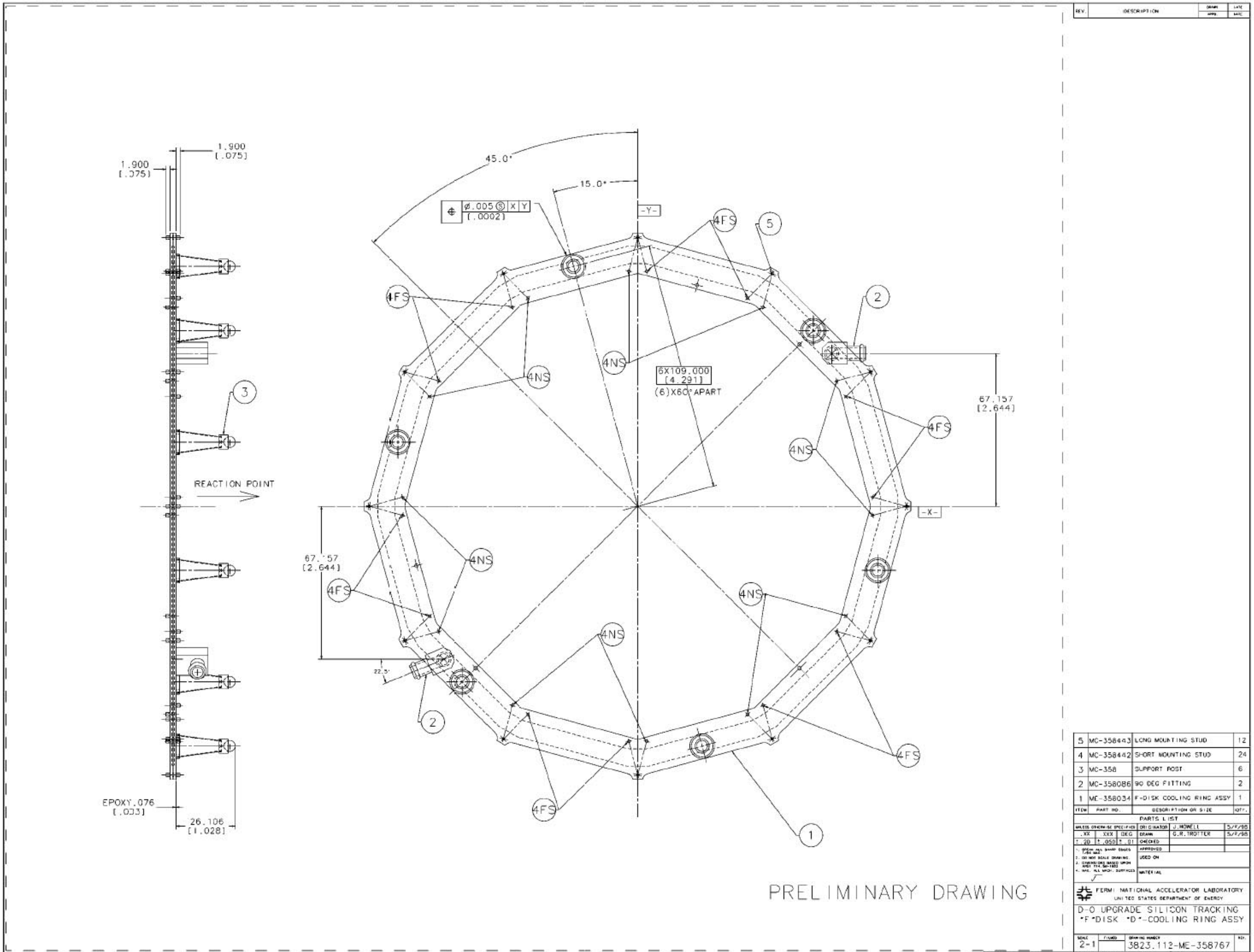
5 MC-358443 LONG MOUNTING STUD 12
4 MC-358442 SHORT MOUNTING STUD 24
3 MC-358 SUPPORT POST 9
2 MC-358086 90 DEG FITTING 2
1 ME-358034 F-DISK COOLING RING ASSY 1
ITEM PART NO. DESCRIPTION OR SIZE QTY.
PARTS LIST
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-0 UPGRADE SILICON TRACKING
"F"DISK "C"-COOLING RING ASSY
3823.112-ME-358766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15.0°
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5
4FS
2
4NS
4NS
6X109.000
[4.291]
(6)X60° APART
67.157
[2.644]
3
4FS
4NS
REACTION POINT
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4FS
4NS
4NS
22.5°
2
4FS
4FS
1
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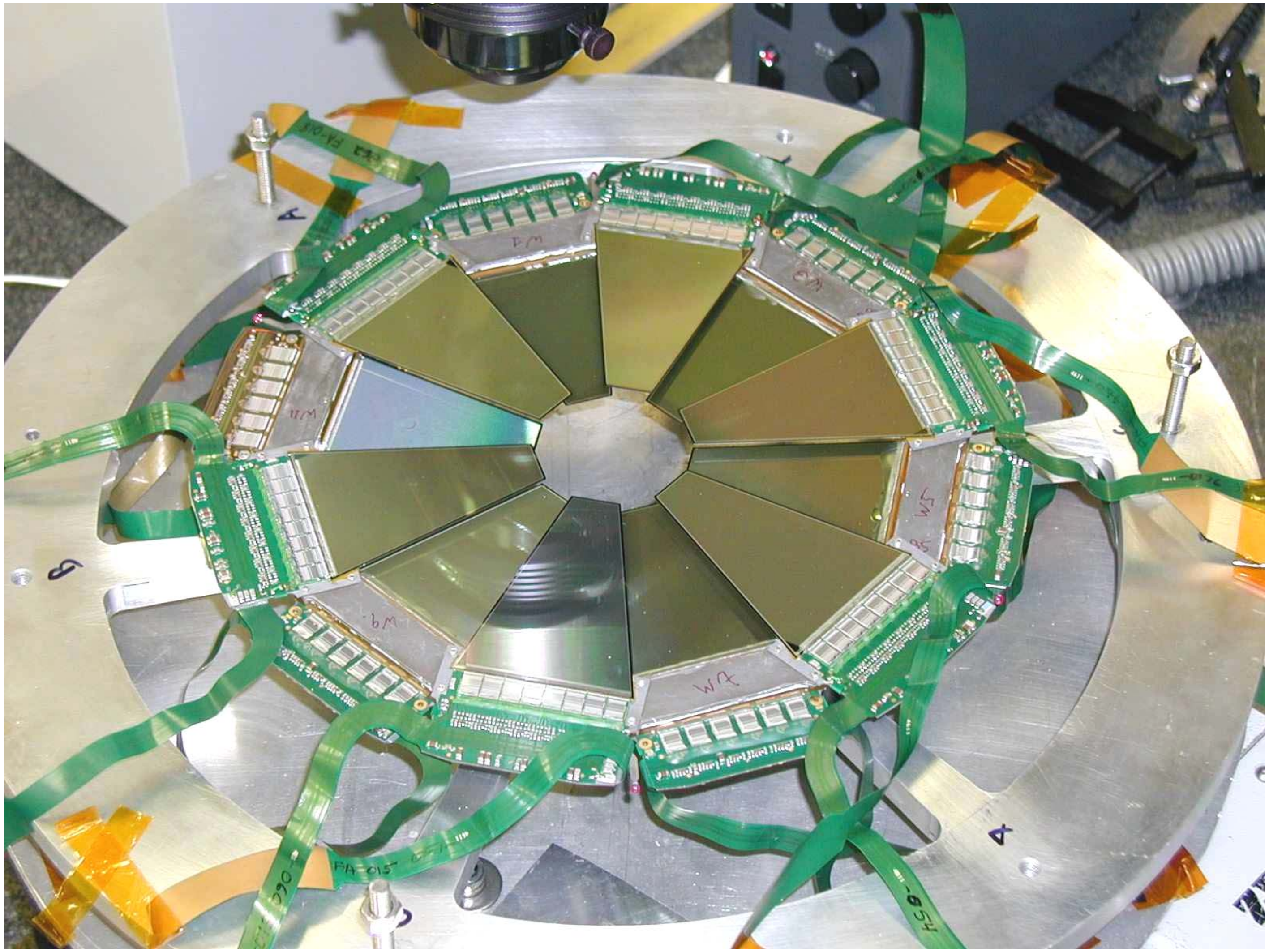
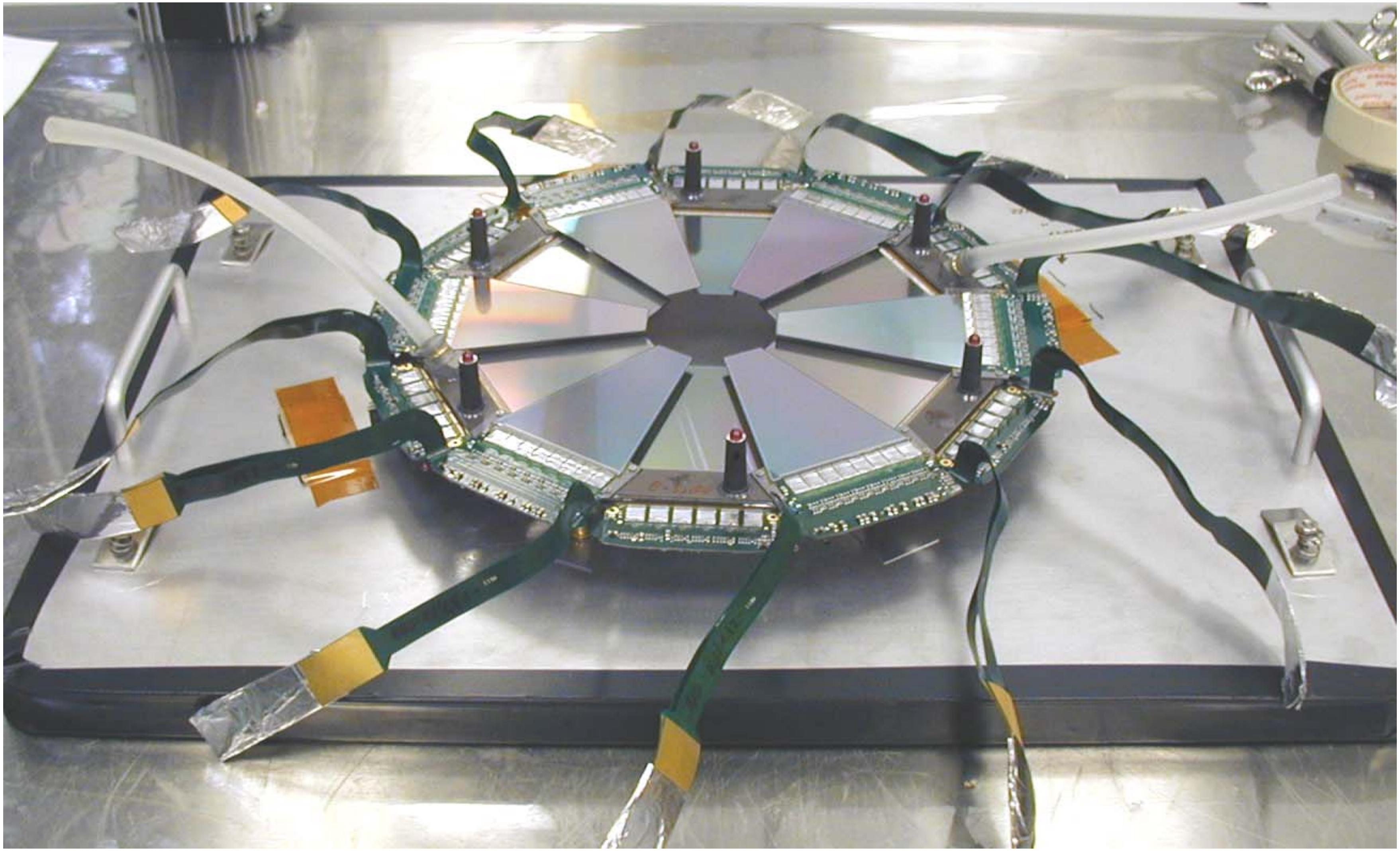
26.106
[1.028]
PRELIMINARY DRAWING
5 MC-358443 LONG MOUNTING STUD 12
4 MC-358442 SHORT MOUNTING STUD 24
3 MC-358 SUPPORT POST 6
2 MC-358086 90 DEG FITTING 2
1 ME-358034 F-DISK COOLING RING ASSY 1
ITEM PART NO. DESCRIPTION OR SIZE QTY.
PARTS LIST
ORIGINATOR J.HOWELL 5/?/98
DRAWN G.R.TROTTER 5/?/98
CHECKED
APPROVED
USED ON
MATERIAL
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-0 UPGRADE SILICON TRACKING
"F"DISK "D"-COOLING RING ASSY
SCALE 2-1
DRAWING NUMBER 3823.112-ME-358767
CREATED WITH I-DEAS_VI
USER NAME:

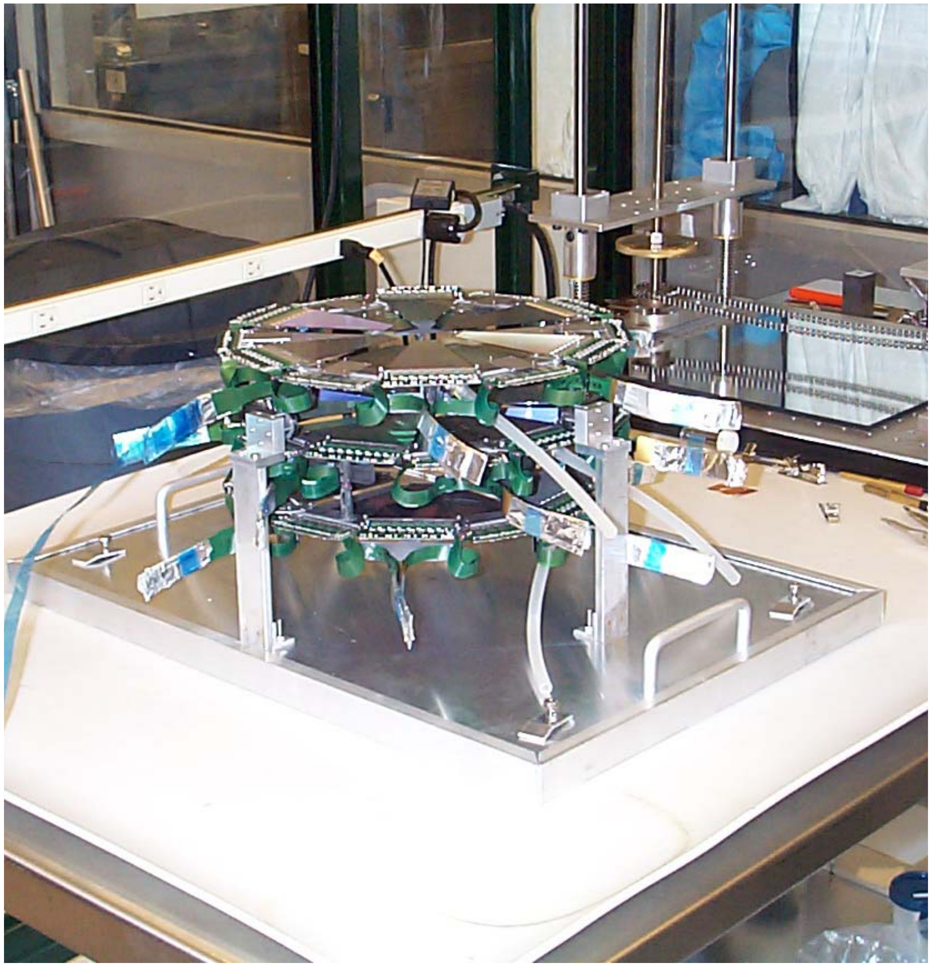
F-wedge Installation on Cooling Ring

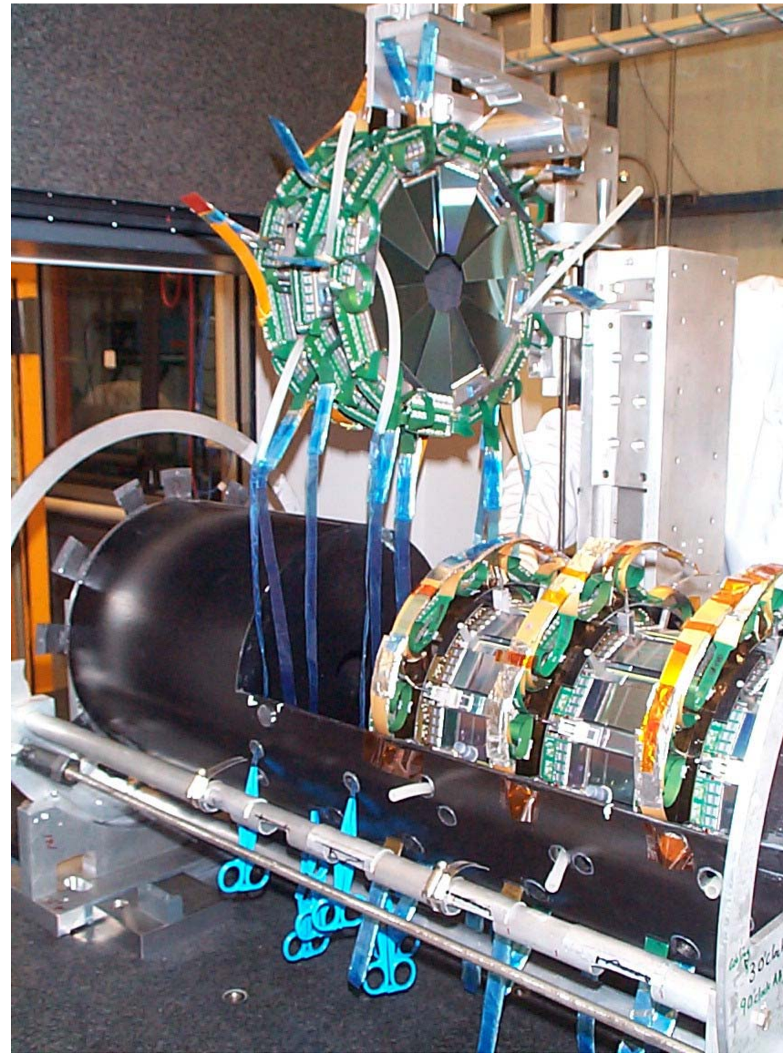


F-disk Assembly

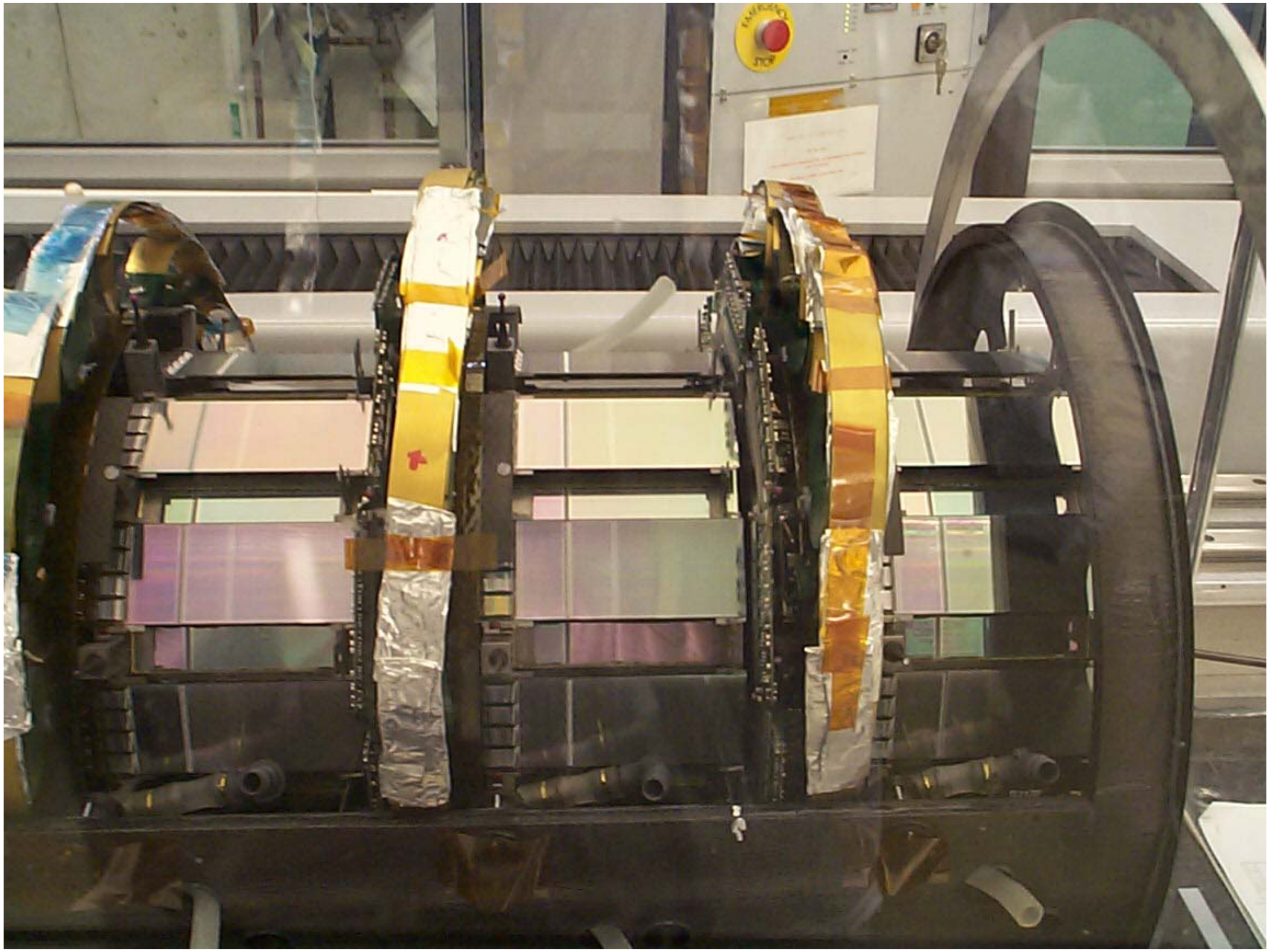


Assembly & Installation of End F-disk Module

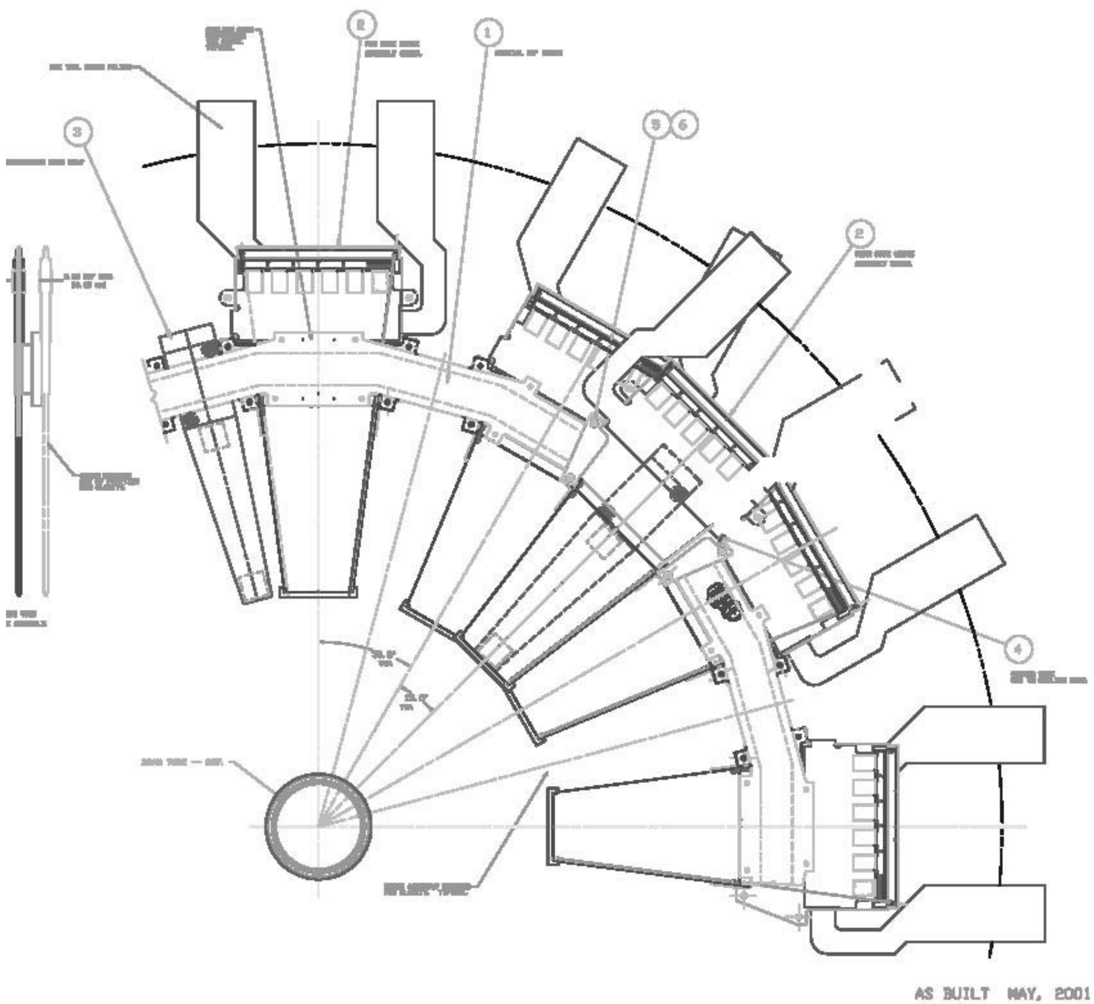




Barrel / F-disk Modules in Support Cylinder

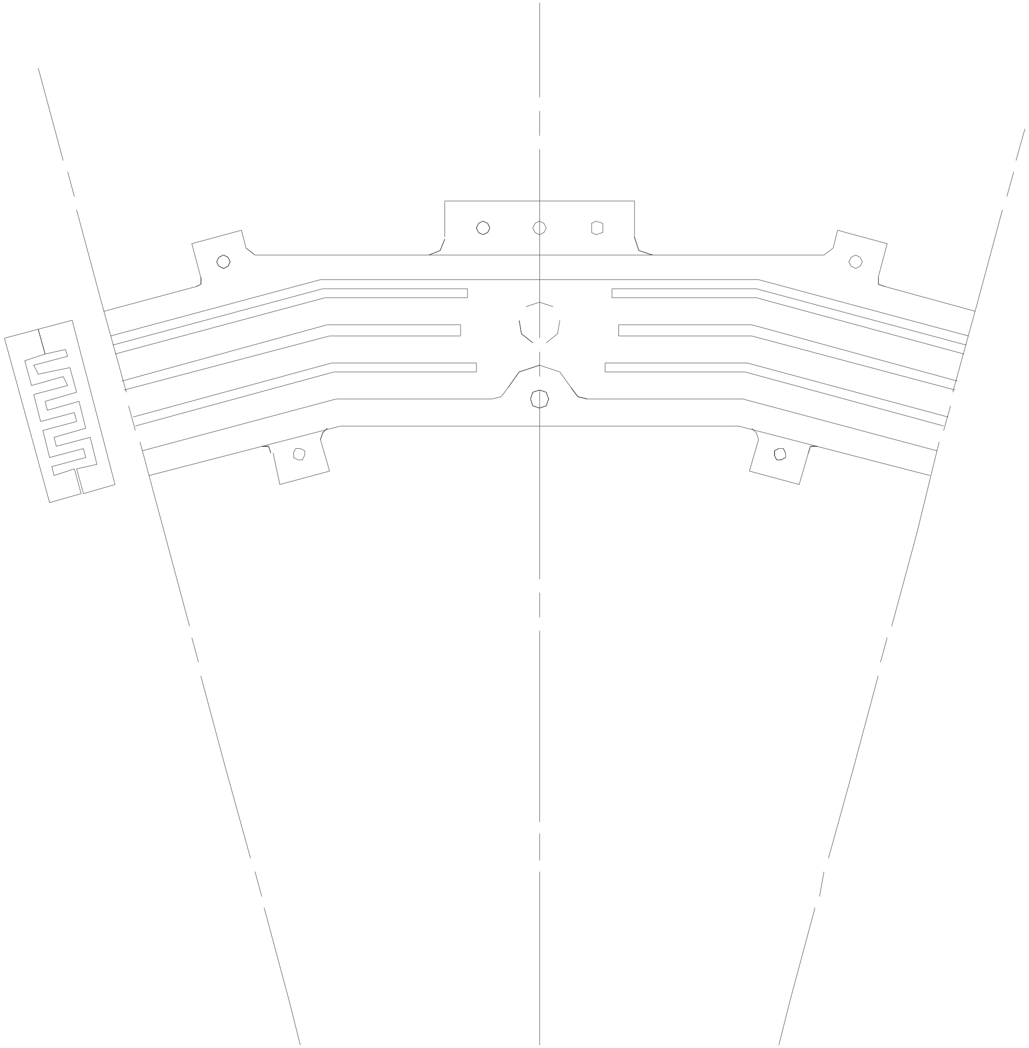


H-disk Design



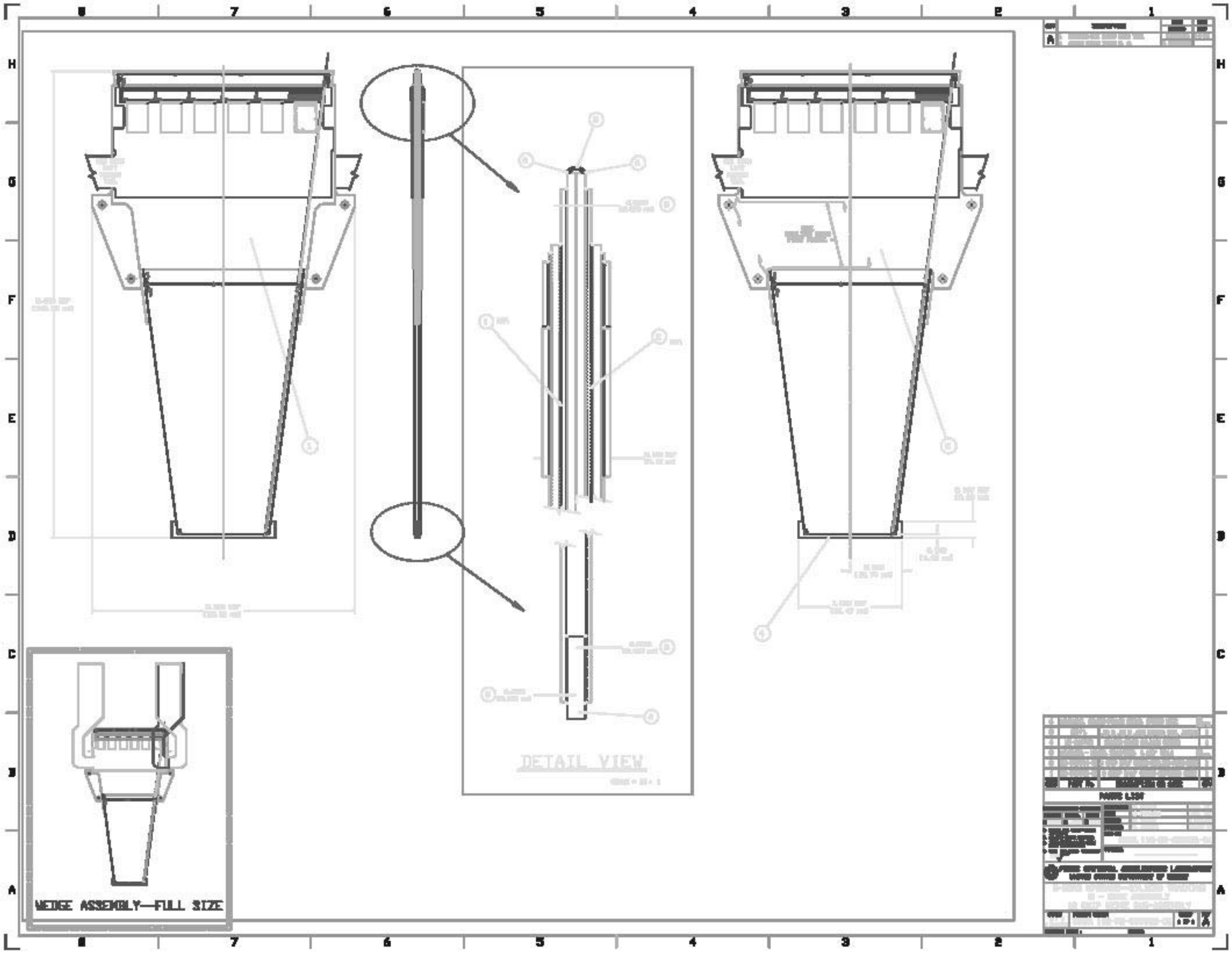
- Silicon IR = 95.865 mm, OR = 236.109 mm at wedge centerline
- Readout mounts on the outer of two wedge sensors at a given ϕ
- Pitch adapters on silicon substrates match sensor pitch to SVX-IIe pitch.
- Beryllium substrates position inner and outer sensors with respect to cooling channel
- Back-to-back wedges provide stereo
- Effective stereo angle = 15^o
- Trace pitch = 40 μm
- Readout pitch = 80 μm

H-disk Cooling / Support Channel

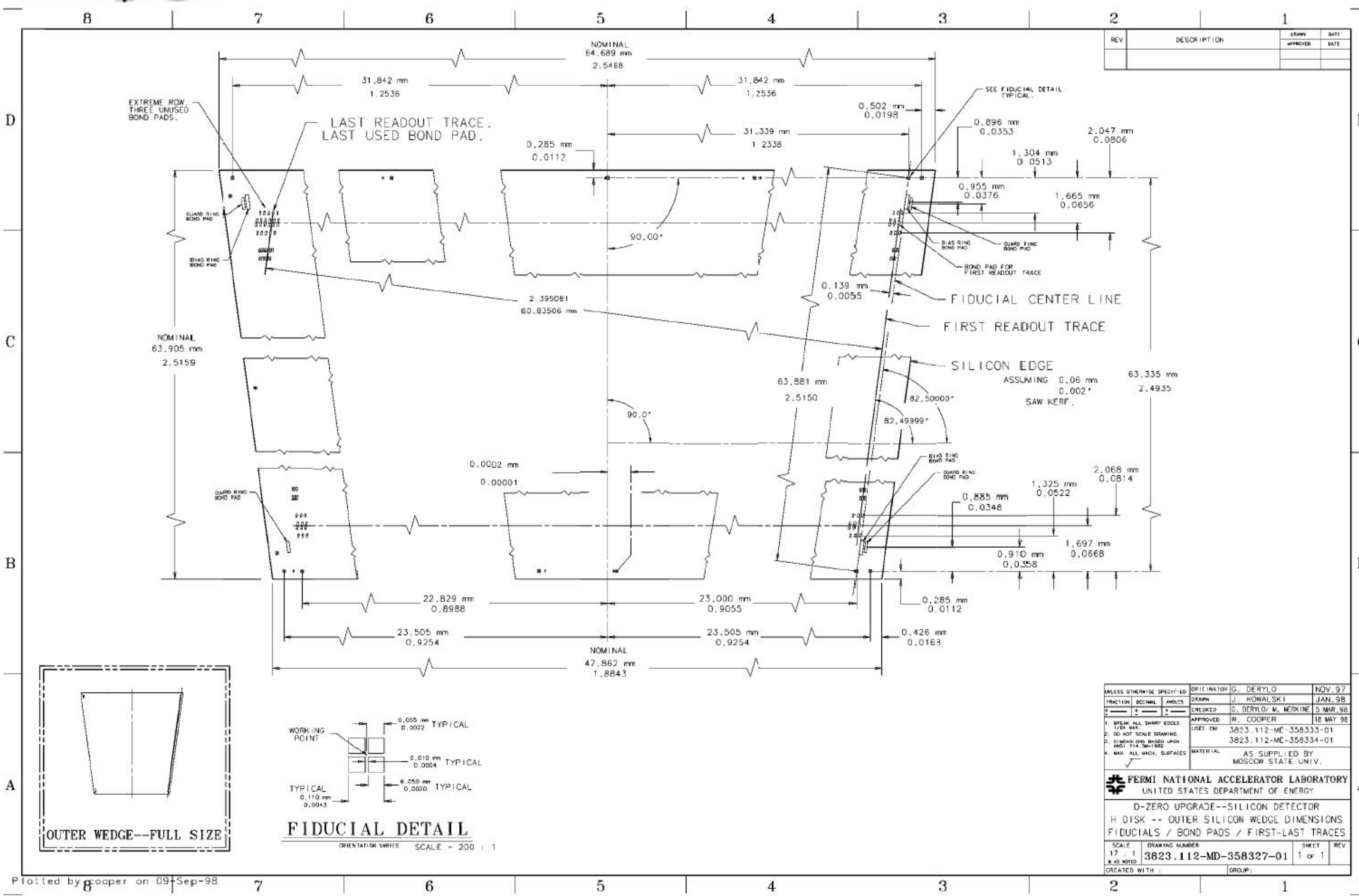


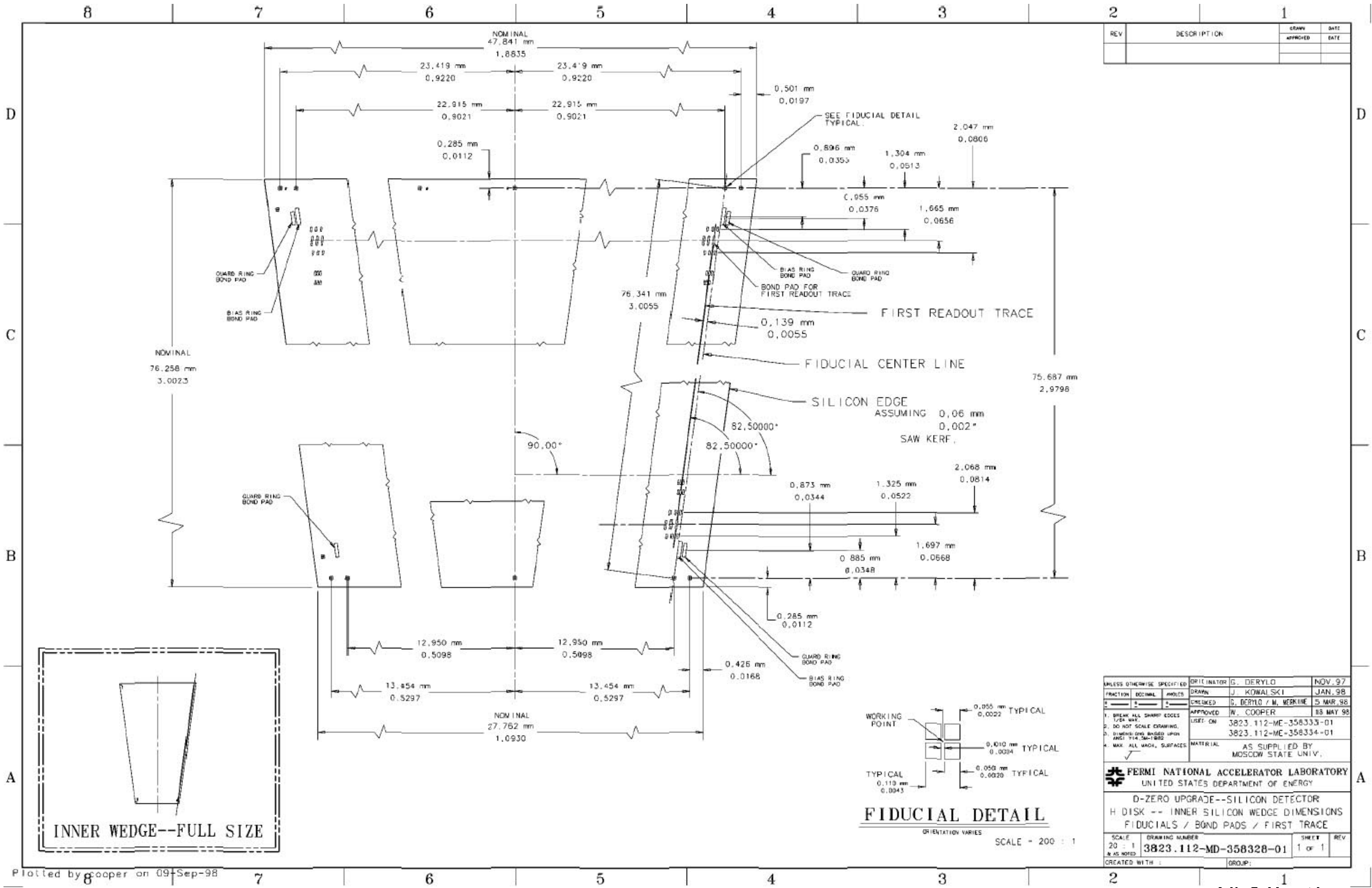
- Considerable effort went into optimizing cooling channel geometry to obtain good heat transfer while maintaining acceptable pressure drop.
- The h-disk channels are the most extreme case, with a fingered design to increase the effective surface area.

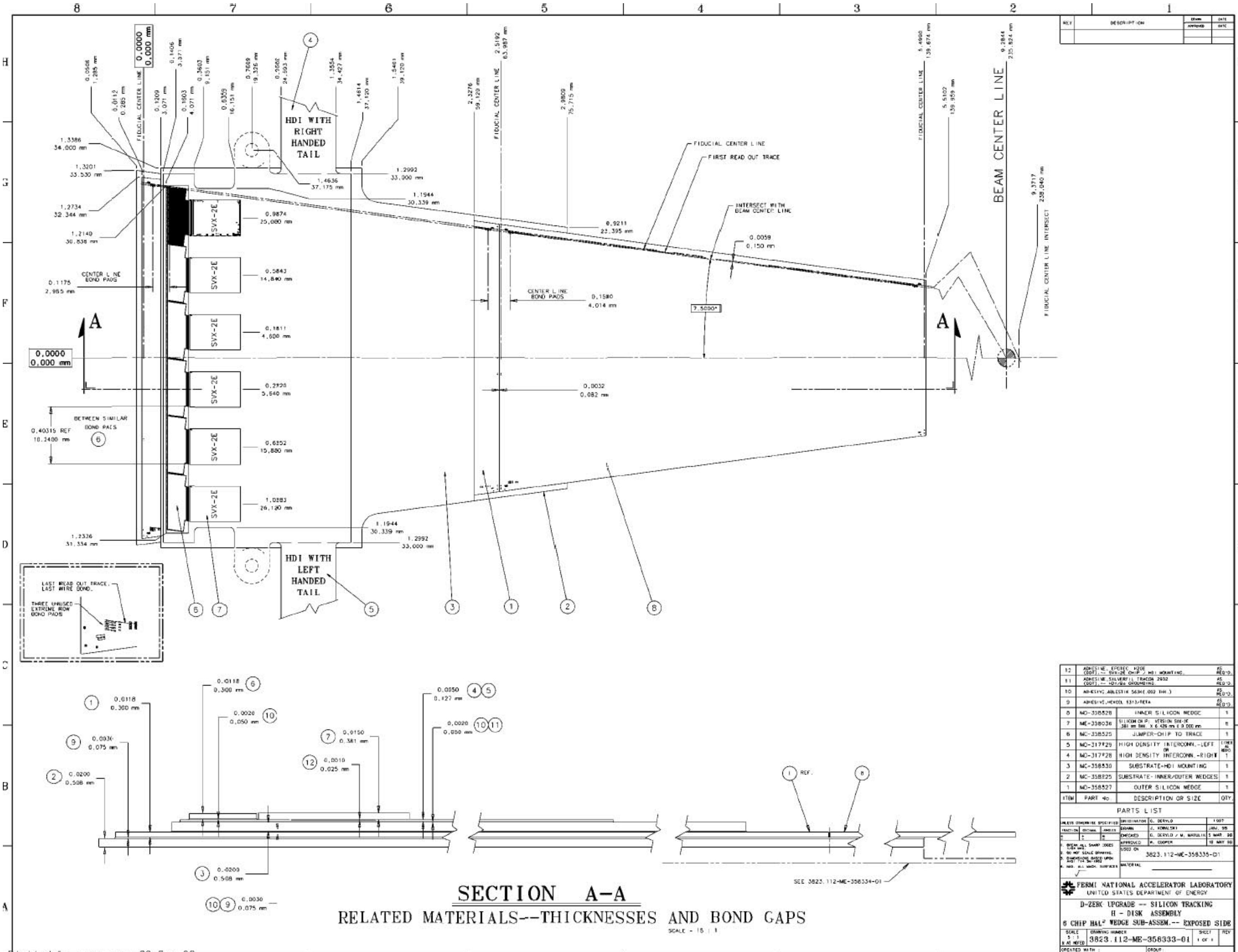
H-disk Four-Sensor Wedge

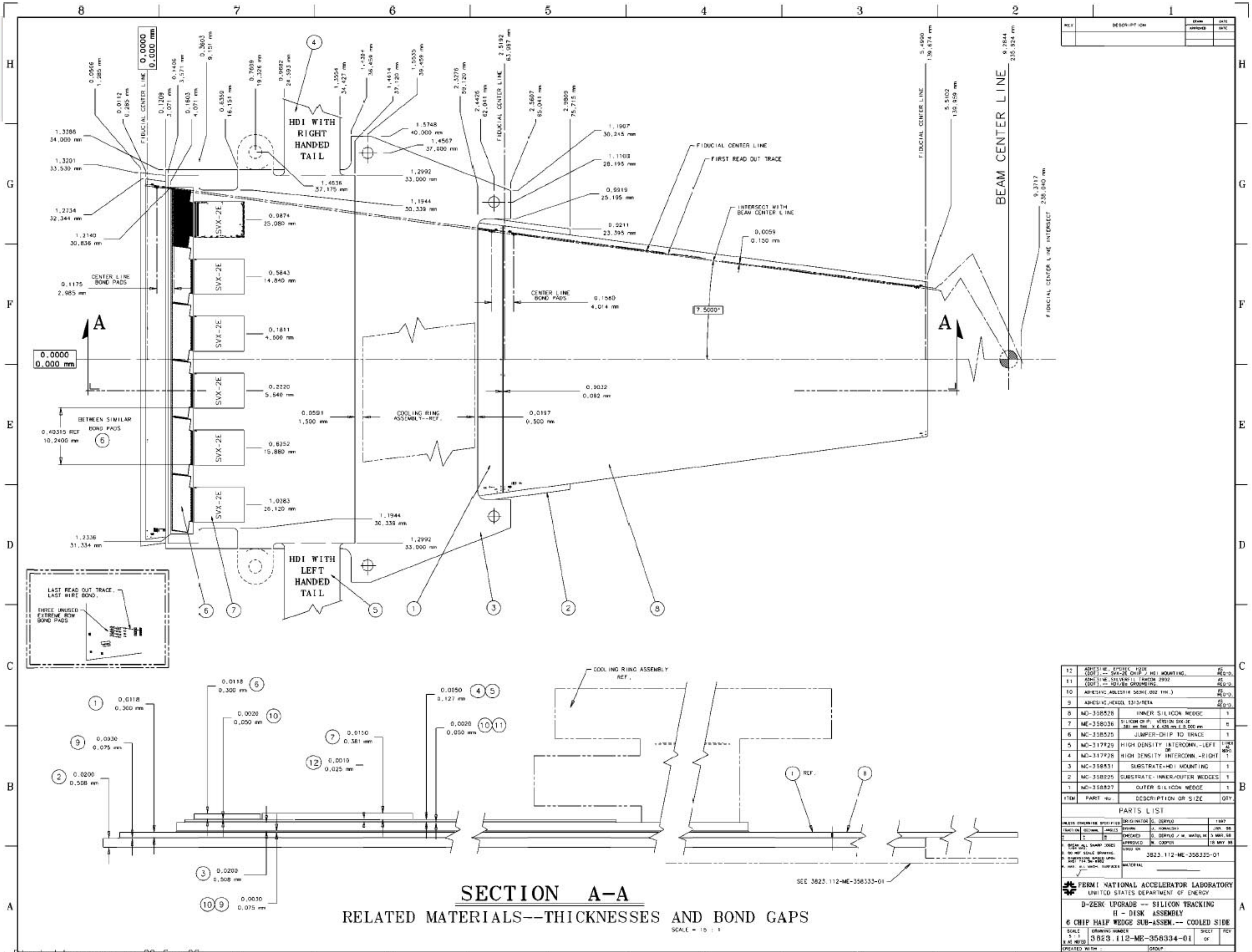


- Probably the most ambitious of the Run II designs
- Inner and outer wedges are aligned on their beryllium readout substrate to form a "Half-wedge".
- Two half-wedges are aligned back-to-back to form a "Full-wedge" and provide stereo.

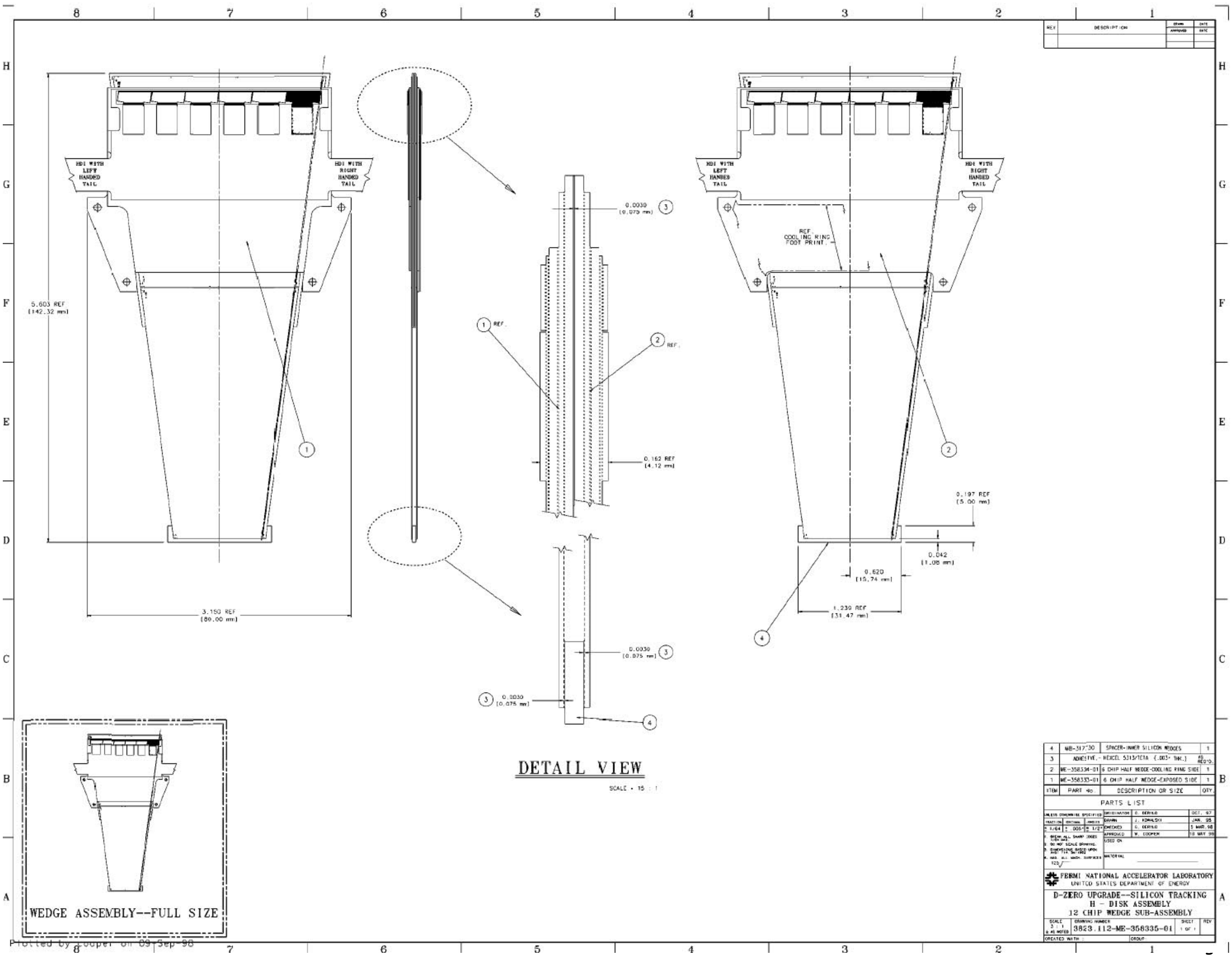

NOMINAL
64.689 mm
2.5468
31.842 mm
1.2536
EXTREME ROW, THREE UNUSED BOND PADS.
LAST READOUT TRACE.
LAST USED BOND PAD.
0.285 mm
0.0112
31.339 mm
1.2338
SEE FIDUCIAL DETAIL TYPICAL.
0.502 mm
0.0198
0.896 mm
0.0353
1.304 mm
0.0513
2.047 mm
0.0806
0.955 mm
0.0376
1.665 mm
0.0656
90.00°
BIAS RING BOND PAD
GUARD RING BOND PAD
BOND PAD FOR FIRST READOUT TRACE
0.139 mm
0.0055
FIDUCIAL CENTER LINE
2.395081
60.83506 mm
FIRST READOUT TRACE
NOMINAL
63.905 mm
2.5159
SILICON EDGE
ASSUMING 0.06 mm
0.002" SAW KERF.
63.881 mm
2.5150
63.335 mm
2.4935
82.50000°
82.49999°
90.0°
0.0002 mm
0.00001
2.068 mm
0.0814
1.325 mm
0.0522
0.885 mm
0.0348
1.697 mm
0.0668
0.910 mm
0.0358
22.829 mm
0.8988
23.000 mm
0.9055
0.285 mm
0.0112
23.505 mm
0.9254
0.426 mm
0.0163
NOMINAL
47.862 mm
1.8843
OUTER WEDGE--FULL SIZE
WORKING POINT
0.055 mm
0.0022 TYPICAL
0.010 mm
0.0004 TYPICAL
0.050 mm
0.0020 TYPICAL
TYPICAL
0.110 mm
0.0043
FIDUCIAL DETAIL
ORIENTATION VARIES SCALE - 200 : 1
ORIGINATOR G. DERYLO NOV.97
DRAWN J. KOWALSKI JAN.98
CHECKED G. DERYLO/ M. MERKINE 5 MAR.98
APPROVED W. COOPER 18 MAY 98
USED ON 3823.112-ME-358333-01
3823.112-ME-358334-01
MATERIAL AS SUPPLIED BY MOSCOW STATE UNIV.
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE--SILICON DETECTOR
H DISK -- OUTER SILICON WEDGE DIMENSIONS
FIDUCIALS / BOND PADS / FIRST-LAST TRACES
SCALE 17 : 1
DRAWING NUMBER 3823.112-MD-358327-01
SHEET 1 OF 1
Plotted by cooper on 09-Sep-98


NOMINAL
47.841 mm
1.8835
23.419 mm
0.9220
22.915 mm
0.9021
0.501 mm
0.0197
SEE FIDUCIAL DETAIL TYPICAL.
0.285 mm
0.0112
GUARD RING BOND PAD
BIAS RING BOND PAD
BOND PAD FOR FIRST READOUT TRACE
FIRST READOUT TRACE
0.139 mm
0.0055
FIDUCIAL CENTER LINE
SILICON EDGE
ASSUMING 0.06 mm
0.002"
SAW KERF.
76.341 mm
3.0055
NOMINAL
76.258 mm
3.0023
75.687 mm
2.9798
82.50000°
90.00°
12.950 mm
0.5098
13.454 mm
0.5297
NOMINAL
27.762 mm
1.0930
0.426 mm
0.0168
INNER WEDGE--FULL SIZE
WORKING POINT
FIDUCIAL DETAIL
SCALE = 200 : 1
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE--SILICON DETECTOR
H DISK -- INNER SILICON WEDGE DIMENSIONS
FIDUCIALS / BOND PADS / FIRST TRACE
3823.112-MD-358328-01
Plotted by cooper on 09-Sep-98


HDI WITH RIGHT HANDED TAIL
HDI WITH LEFT HANDED TAIL
BEAM CENTER LINE
FIDUCIAL CENTER LINE
FIRST READ OUT TRACE
INTERSECT WITH BEAM CENTER LINE
CENTER LINE BOND PADS
BETWEEN SIMILAR BOND PADS
LAST READ OUT TRACE, LAST WIRE BOND.
THREE UNUSED EXTREME ROW BOND PADS
SVX-2E
A
SECTION A-A
RELATED MATERIALS--THICKNESSES AND BOND GAPS
SEE 3823.112-ME-358334-01
12 ADHESIVE, EPOTEC H20E (DOT). -- SVX-2E CHIP / HDI MOUNTING. AS REQ'D.
11 ADHESIVE, SILVERFIL TRACON 2902 (DOT). -- HDI/Be GROUNDING. AS REQ'D.
10 ADHESIVE, ABLESTIK 563K (.002 THK.) AS REQ'D.
9 ADHESIVE, HEXCEL 5313/TETA AS REQ'D.
8 MD-358528 INNER SILICON WEDGE 1
7 ME-358036 SILICON CHIP, VERSION SVX-2E 6
6 MC-358525 JUMPER-CHIP TO TRACE 1
5 MD-317#29 HIGH DENSITY INTERCONN.-LEFT
OR
4 MD-317#28 HIGH DENSITY INTERCONN.-RIGHT 1
3 MC-358530 SUBSTRATE-HDI MOUNTING 1
2 MC-358825 SUBSTRATE-INNER/OUTER WEDGES 1
1 MD-358527 OUTER SILICON WEDGE 1
ITEM PART No. DESCRIPTION OR SIZE QTY.
PARTS LIST
ORIGINATOR G. DERYLO
DRAWN J. KOWALSKI JAN. 98
CHECKED G. DERYLO / M. MATULIK
APPROVED W. COOPER
USED ON 3823.112-ME-358335-01
MATERIAL
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE -- SILICON TRACKING
H - DISK ASSEMBLY
6 CHIP HALF WEDGE SUB-ASSEM.-- EXPOSED SIDE
SCALE 5:1
DRAWING NUMBER 3823.112-ME-358333-01
CREATED WITH :
GROUP:



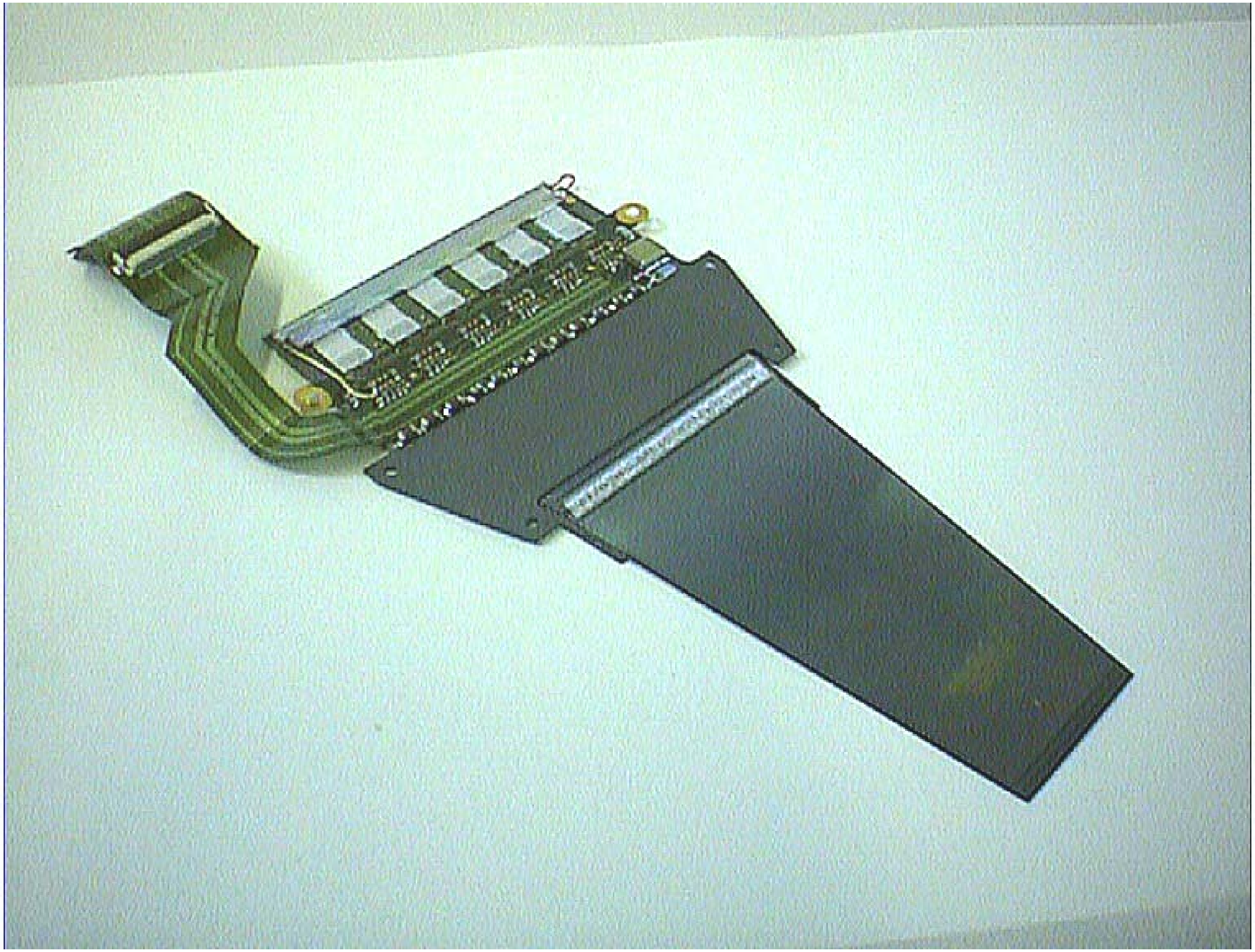
HDI WITH RIGHT HANDED TAIL
HDI WITH LEFT HANDED TAIL
BEAM CENTER LINE
FIDUCIAL CENTER LINE
FIRST READ OUT TRACE
INTERSECT WITH BEAM CENTER LINE
FIDUCIAL CENTER LINE INTERSECT
CENTER LINE BOND PADS
BETWEEN SIMILAR BOND PADS
COOLING RING ASSEMBLY--REF.
SVX-2E
7.5000°
A
LAST READ OUT TRACE, LAST WIRE BOND.
THREE UNUSED EXTREME ROW BOND PADS
COOLING RING ASSEMBLY REF.
SEE 3823.112-ME-358333-01
SECTION A–A
RELATED MATERIALS--THICKNESSES AND BOND GAPS
12 ADHESIVE, EPOTEC H20E (DOT).-- SVX-2E CHIP / HDI MOUNTING. AS REQ'D.
11 ADHESIVE, SILVERFIL TRACON 2902 (DOT).-- HDI/Be GROUNDING. AS REQ'D.
10 ADHESIVE, ABLESTIK 563K(.002 THK.) AS REQ'D.
9 ADHESIVE, HEXCEL 5313/TETA AS REQ'D.
8 MD-358528 INNER SILICON WEDGE 1
7 ME-358036 SILICON CHIP; VERSION SVX-2E 1
6 MC-358525 JUMPER-CHIP TO TRACE 1
5 MD-317929 HIGH DENSITY INTERCONN.-LEFT
OR
4 MD-317928 HIGH DENSITY INTERCONN.-RIGHT 1
3 MC-358531 SUBSTRATE-HDI MOUNTING 1
2 MC-358225 SUBSTRATE-INNER/OUTER WEDGES 1
1 MD-358527 OUTER SILICON WEDGE 1
ITEM PART No. DESCRIPTION OR SIZE QTY.
PARTS LIST
ORIGINATOR G. DERYLO 1997
APPROVED W. COOPER 18 MAY 98
USED ON 3823.112-ME-358335-01
MATERIAL
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE -- SILICON TRACKING
H - DISK ASSEMBLY
6 CHIP HALF WEDGE SUB-ASSEM.-- COOLED SIDE
DRAWING NUMBER 3823.112-ME-358334-01
CREATED WITH :
GROUP :


HDI WITH LEFT HANDED TAIL
HDI WITH RIGHT HANDED TAIL
5.603 REF [142.32 mm]
3.150 REF [80.00 mm]
0.0030 [0.075 mm]
0.162 REF [4.12 mm]
REF. COOLING RING FOOT PRINT.
0.197 REF [5.00 mm]
0.042 [1.06 mm]
0.620 [15.74 mm]
1.239 REF [31.47 mm]
DETAIL VIEW
SCALE = 15 : 1
WEDGE ASSEMBLY--FULL SIZE
PARTS LIST
4 MB-317730 SPACER-INNER SILICON WEDGES 1
3 ADHESIVE,- HEXCEL 5313/TETA (.003" THK.) AS REQ'D.
2 ME-358334-01 6 CHIP HALF WEDGE-COOLING RING SIDE 1
1 ME-358333-01 6 CHIP HALF WEDGE-EXPOSED SIDE 1
ITEM PART NO. DESCRIPTION OR SIZE QTY.
ORIGINATOR C. DERYLO OCT. 97
DRAWN J. KOWALSKI JAN. 98
CHECKED G. DERYLO 5 MAR. 98
APPROVED W. COOPER 18 MAY 98
USED ON
MATERIAL
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
D-ZERO UPGRADE--SILICON TRACKING
H - DISK ASSEMBLY
12 CHIP WEDGE SUB-ASSEMBLY
SCALE 3 : 1 & AS NOTED
DRAWING NUMBER 3823.112-ME-358335-01
SHEET 1 OF 1
REV
Plotted by cooper on 09-Sep-98

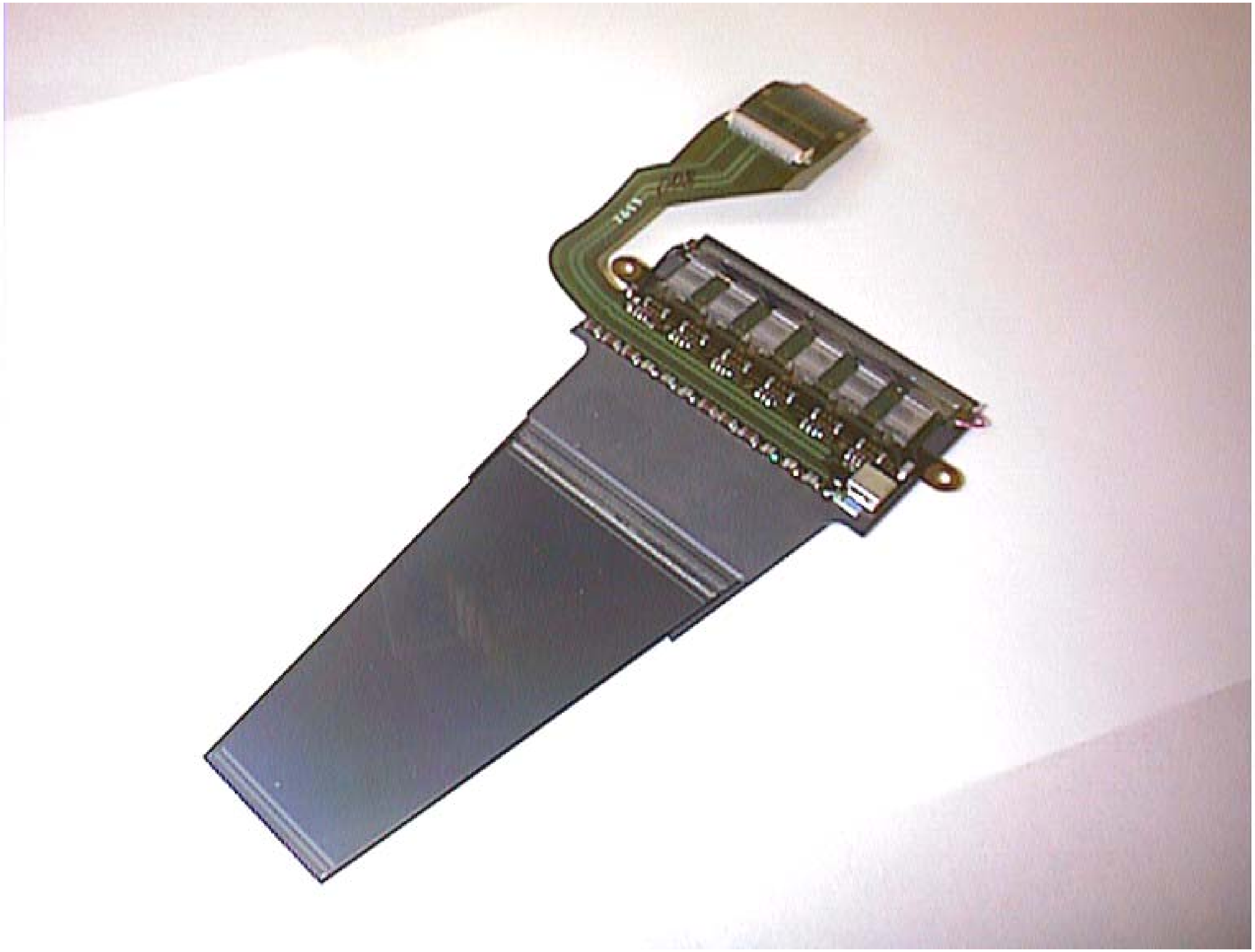
H-disk People

- We benefited from strong Russian and Kansas State participation on H-disks. The primary Fermilab engineer was Greg Derylo. Greg Sellberg was crucial to the development of the dual camera alignment system.

Half-wedge Cooled Assembly



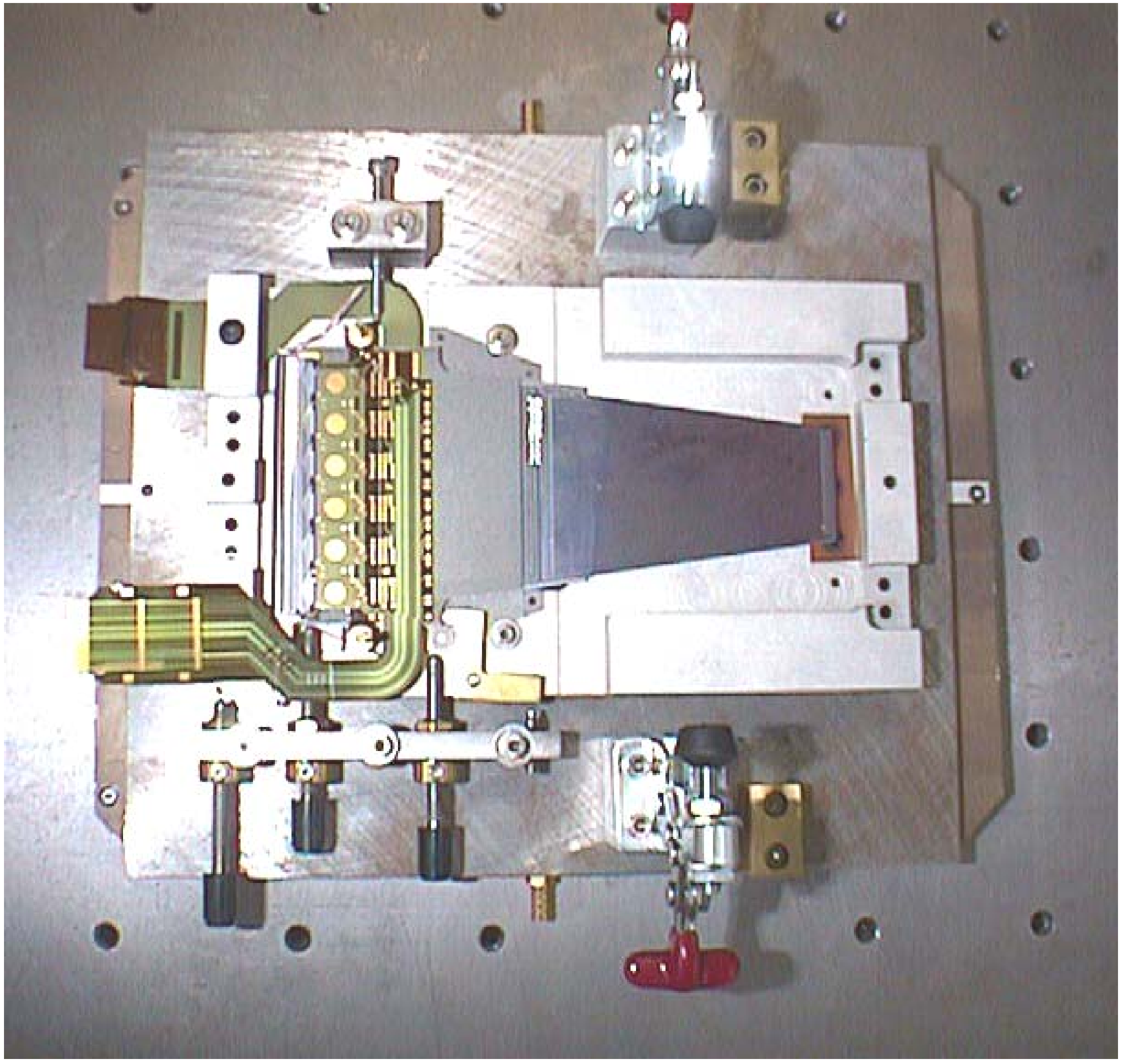
Half-wedge Exposed Assembly



W. E. Cooper, Fermilab

Full-wedge Back-to-back Alignment

- Dual, collinear Nikon camera system on a Zeiss UMM500 CMM

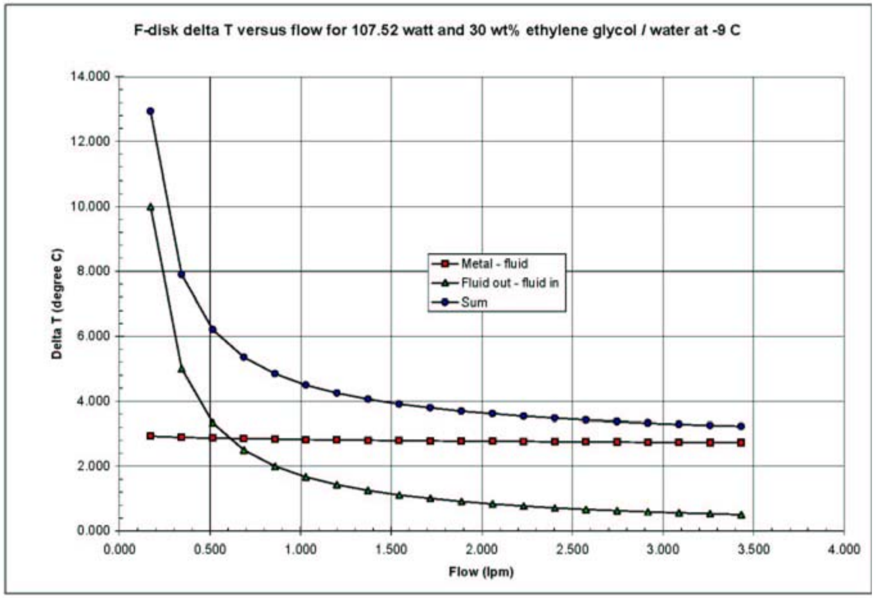


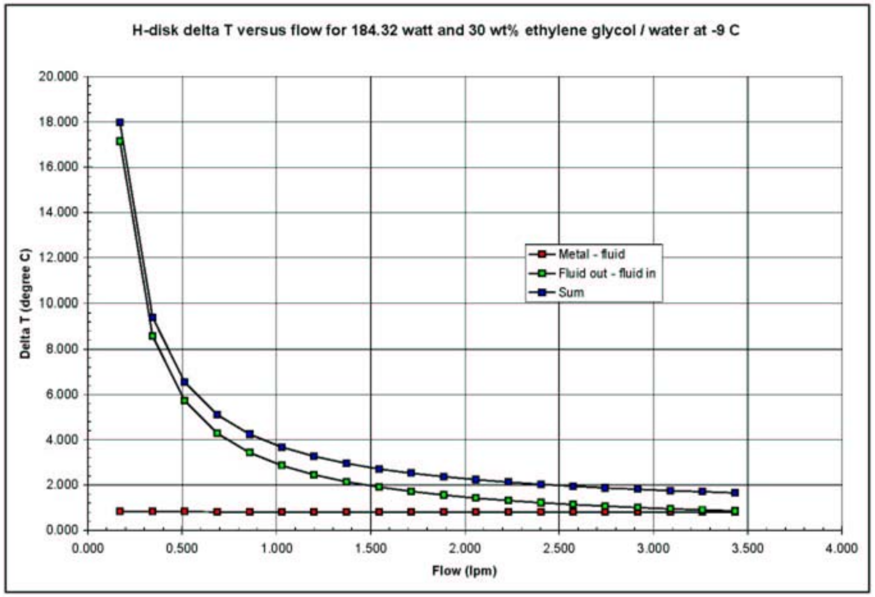
Cooling

- All cooling is based upon the flow of an ethylene glycol – water mixture through beryllium channels which are in good thermal contact with sensor assemblies.
  - The original design assumed a coolant temperature of 0^o to $+5^o$ C and a heat load of 0.64 watts per SVX chip.
  - A conservative design and lower chip power dissipation allow colder operation.
  - The present coolant temperature is -9^o C; actual power dissipation is 0.46 watts per SVX chip.
  - Sub-atmospheric operation limits the delta P available. The final design delta P is 8 psi from the end of a supply manifold to the end of a return manifold.
  - The cooling system has worked reliably since day 1.
- Sensor support structure designs have been chosen which minimize thermal positional distortions in cooling from room temperature to operating temperature.
- Silicon temperature within a given sensor varies with location.

Cooling

- Temperature difference between beryllium metal surface to which wedges mount and bulk coolant for –9° C coolant
  - Orifices are used to balance flows.
  - Nominal F-disk flow = 1.35 lpm; actual silicon temperature < -4° C
  - Nominal H-disk flow = 1.30 lpm; actual silicon temperature < -5° C
  - Final SVX-IIe chip dissipation is 70% of original design value, so temperature rises are proportionately lower than those shown below.





Conclusion

- The simultaneous design development and construction of barrels, F-disks, H-disks, and associated fixturing, with limited previous D0 silicon experience, was a substantial undertaking.
- Most of the designs are well-documented with drawings.
- Design took 3$^+$ years; procurement, fabrication, assembly, testing, and installation took 4 years.
- The tracker has been in operation since the spring of 2001.
- The mechanical designs have proven to be sound and alignment has been very good.